NOVEMBER 13, 1961

missiles and rockets

THE MISSILE/SPACE WEEKLY

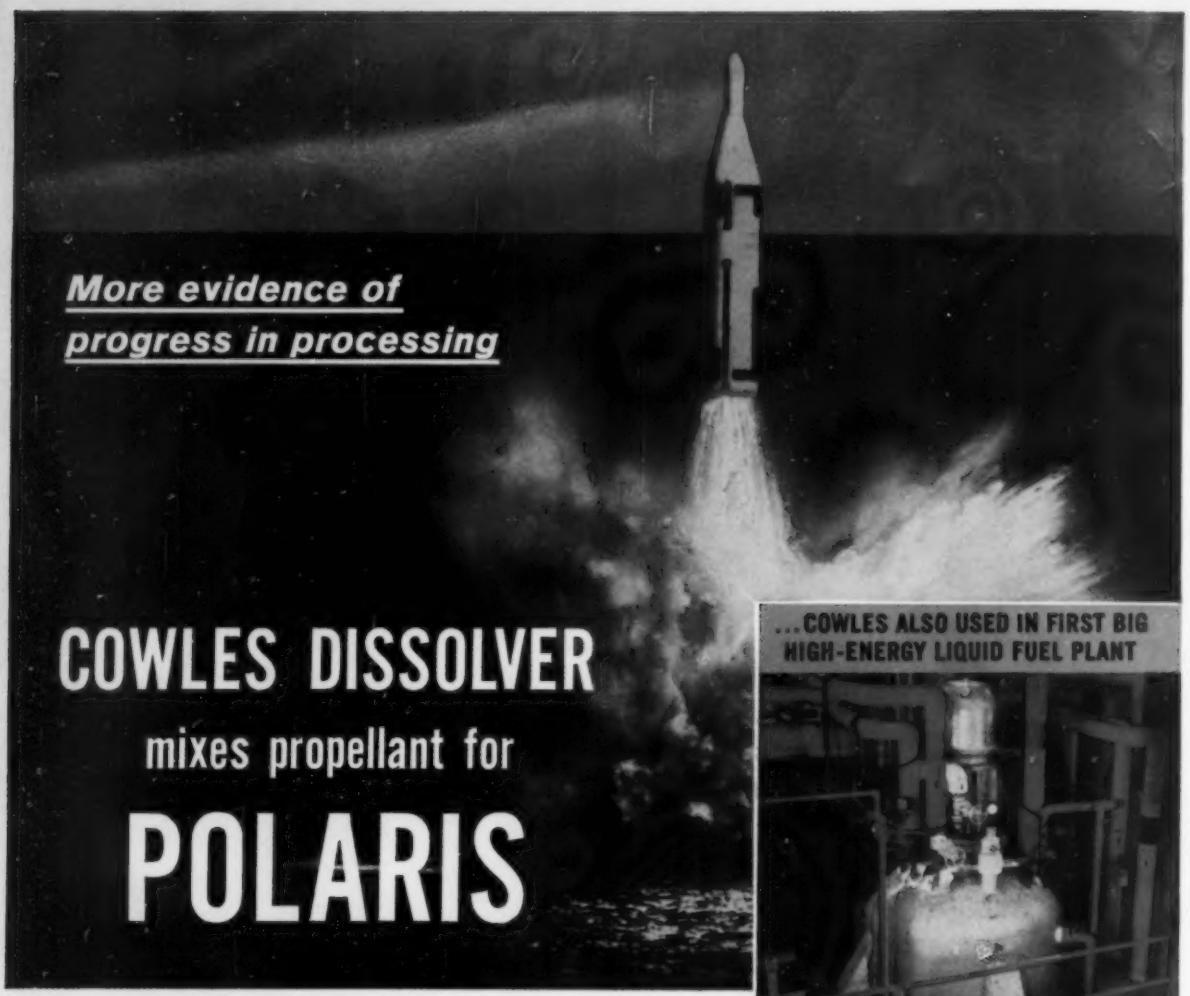
THE UNIVERSITY OF MICHIGAN
NOV 14 1961
ENGINEERING LIBRARY

Challenger Cresap of Westinghouse

The Electronics Surge into 'Big Ten' . . . .
NASA Readies Three-Orbit Monkey Shot
Big Booster Case Work at Excelco 22

UNIV OF MICHIGAN
ATT GEN LIB ORDER DEPT
ANN ARBOR MICHIGAN
2-15-71

AN AMERICAN AVIATION PUBLICATION



More evidence of progress in processing

COWLES DISSOLVER

mixes propellant for

POLARIS

...COWLES ALSO USED IN FIRST BIG HIGH-ENERGY LIQUID FUEL PLANT

One of Cowles Dissolvers installed in $38,000,000 Hi Cal® plant being operated for the Navy by Callery Chemical Company at Muskogee, Oklahoma.

Two outstanding examples of special applications for critical dispersion efficiency

To meet the challenge of producing space-age fuels in big volume for missiles and rockets (including the great Polaris) Aerojet General Corp. engineers have recently completed a change from batch-type mixing to the first continuous process for propellants.

Under their direction Cowles dispersing specialists adapted a giant "COWLES DISSOLVER" to the highly critical operations involved, with noteworthy advantages.

1. *Big volume fuel production for large missiles and rockets became practical for first time.*
2. *Labor costs were cut 80%.*
3. *Fire and explosion hazards were greatly reduced.*
4. *Higher quality and greater uniformity in end products were attained.*

Because the "COWLES DISSOLVER" provided the best pattern of dispersing materials and compounds to fine particle size in the shortest possible time, six of the largest types were specially designed for the Callery Chemical Company plant (see illustration). Close cooperation between Callery engineers and Cowles application specialists led from a two-stage operation to a single-step method combining the dispersion and reaction stages.

Unique features offer exotic fuel advantages

Cowles dissolving begins where conventional mixing stops. The patented Cowles impeller imparts high velocity to materials, creating intense turbulence and producing multi-phase, multi-directional action and hydraulic attrition between the particles. The exclusive M P D* (Maximum Power Delivery) drive is capable of delivering up to 90% of motor horsepower to the impeller, even at slowest speeds.

Completely homogenous metallic dispersions to particle size as small as two microns are finished in a fraction of the time required by ordinary equipment . . . and for many reactions under conditions previously considered impossible.

Self cleaning impeller will not clog with material.

Cowles equipment is compact, versatile, fully instrumented, and lends itself easily to the close and/or remote control necessary with highly active materials.

LET US PROVE ITS ADVANTAGES IN YOUR PLANT AT OUR RISK! Write today for more complete information.

Specialized Application Service Available

Cowles experts have both depth and breadth of experience in critical, high-speed, high shear dispersions unequalled anywhere. Specially designed models for adaptations are available for all purposes—laboratory, pilot plant and full-scale production.

Your inquiry is invited. Perhaps the solution of a problem such as yours is already available from our records. If not, you can be assured of competent assistance in helping you get the right answer.

If your need is urgent or critical, contact the executive nearest you for special attention—

George E. Missbach, General Sales Manager
3330 Peachtree Road, N. E., Atlanta 5, Georgia
Telephone: CEdar 7-1691

H. N. Meyer, Jr., Vice President
Cowles Dissolver Company, Inc.
Cayuga, New York • Telephone: ALbany 3-3214

Hugh F. Purcell, Applications Engineer
Morehouse-Cowles, Inc.
1150 San Fernando Road, Los Angeles 65, California
Telephone: CApital 5-1571

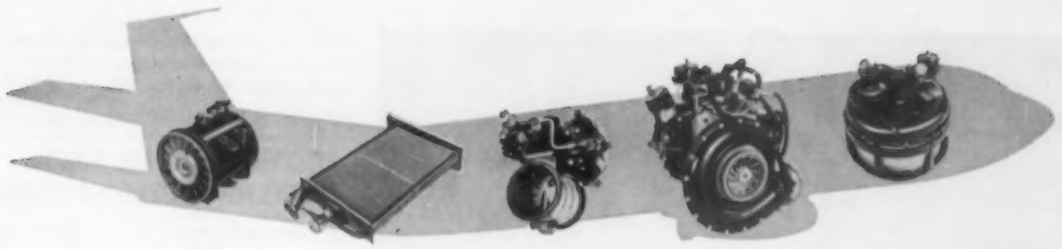
COWLES DISSOLVER®

*Trade Mark

MOREHOUSE-COWLES, INC.
1150 San Fernando Road,
Los Angeles 65, California

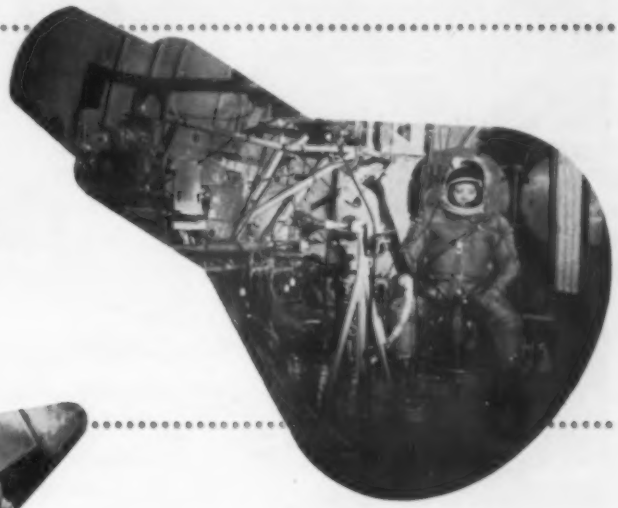
434-A

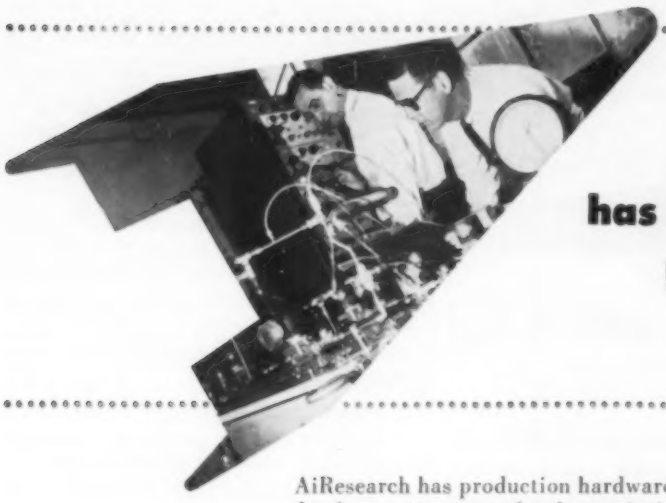
Circle No. 1 on Subscriber Service Card



Only AiResearch has 2 million components in aircraft environmental systems*

Only AiResearch has life support systems for America's astronauts





Only AiResearch has environmental systems <u>now</u> for tomorrow's spacecraft

AiResearch has production hardware experience or has reached advanced stages in development contracts for these principal areas of a space environmental system: space radiators, glycol loops, supercritical cryogenic storage, atmospheric controls, fans, compressors and pumps.

The company's proven ability to produce all the components and integrate them into a complete environmental system reduces the problems of interface and assures the highest degree of optimization.

A new laboratory is now being added to present facilities specifically designed to test environmental control systems for advanced space missions.

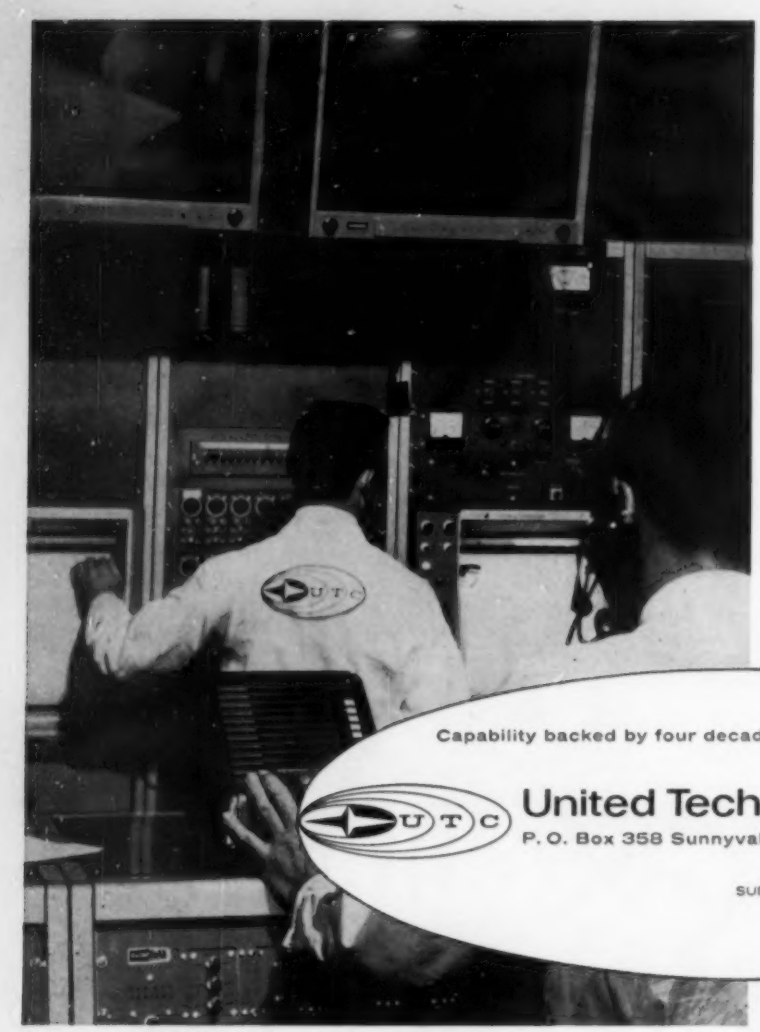
**In world-wide service, with mean time between failure from 5000 to 40,000 hours on major high speed rotating machinery.*

GARRETT

AIRESEARCH MANUFACTURING DIVISIONS • *Los Angeles 45, California • Phoenix, Arizona*

Systems and Components for:
Aircraft, Missile, Spacecraft, Electronic, Nuclear and Industrial Applications

Circle No. 2 on Subscriber Service Card



Left—The scene: UTC Development Center. The action: static firing test is monitored on closed-circuit TV in Remote Control and Data Acquisition Center.

INTERVIEWS NOW ARE BEING CONDUCTED FOR THESE POSITIONS

Sr. Design Engineer—Supervision of a group in design of solid rocket motor components. Requires professional degree and a minimum of 5 years rocket design experience.

Engineering Analyst—Systems Design. To formulate mathematical models of systems engineering problems and implement solutions by analytical techniques. Requires degree with solid mathematical foundation and 2 years design or systems experience.

Organic Chemist—Propellant development research involving synthesis of basic monomers, plasticizers and organic compounds. Requires an advanced degree in organic chemistry with a knowledge of advanced organic synthesis. Experience in synthesis of reactive compounds is most desirable.

Capability backed by four decades of propulsion experience.

United Technology Corporation

P. O. Box 358 Sunnyvale, California

SUBSIDIARY OF UNITED AIRCRAFT CORPORATION

Research Processing Chemist—For laboratory investigations of polymeric materials that may be used as liners, and adhesive or encapsulating agents, and allied research. Strong background in organic chemistry and synthesis including a degree in chemistry or chemical engineering is necessary.

Aerothemo Specialist—Will perform heat transfer thermodynamic and aerodynamic studies on rocket motors, develop new methods of analysis and design tests. Will consult with designers and project engineers on major engine programs. Requires masters degree in mechanical or aeronautical engineering and 4 years experience in thermodynamics and heat transfer.

Process Engineer—For rocket motor processing studies and process methods improvements. Requires chemical engineering degree and direct propellant processing experience.

Propulsion Engineer—For analytical studies of solid and liquid propulsion systems. Requires degree with extensive mathematics, thermodynamics and fluid mechanics background.

All qualified applicants considered without regard to race, creed, color or national origin.

Is there a future for you with UTC?

Are you an engineer or scientist with a record of achievement?

Would you enjoy applying your talents to major programs in advanced propulsion—large segmented solid propellant rocket engines, hybrid rocket engines and storable high energy liquid propellant engines?

Would you find it stimulating to work directly with recognized professional leaders at a modern multi-million-dollar complex, where you could avail yourself of the very latest techniques, methods, ideas and equipment?

Would you appreciate living in the San Francisco Bay area, which features "West Coast living" at its finest? Plus the possibility of financial gain if you can give evidence of real creativity and initiative? This is what the future holds at UTC. If you are interested, we invite you to contact C. F. Gieseler, Dept. 112, United Technology Corporation, Box 358, Sunnyvale, California. All replies treated in strictest confidence.

Circle No. 3 on Subscriber Service Card

THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 9, Number 20 November 13, 1961

President.....Wayne W. Parrish
General Manager.....Leonard A. Eiserer
Editorial Director.....Fred S. Hunter

Editor
William J. Coughlin

Managing Editor
William E. Howard

Senior Editors
James Baar.....Military Affairs
Charles D. LaFond.....Electronics

News Editor
Reed Bundy

Associate Editors
William Beller.....Engineering
Heather M. David.....Space Medicine
John F. Judge.....Advanced Materials
Frank G. McGuire.....Propulsion
David Newman.....Industry
Hal Taylor.....NASA
James Trainor.....Support Equipment
Bill Wilks.....Business

Contributing Editors
James J. Haggerty, Dr. I. M. Levitt, Michael Lorenzo, Dr. Albert Parry, Dr. Hubertus Strughold, G. V. E. Thompson.

Floyd G. Arpan.....Editorial Consultant
Ruby D. Rudd.....Editorial Assistant
William Martin.....Art Director
Bacil Guiley.....Assistant Art Director

BUREAUS
LOS ANGELES.....8929 Wilshire Blvd., Beverly Hills
Richard van Osten.....Bureau Chief
NEW YORK.....20 East 46th Street
PARIS.....11 Rue Condorcet
Jean-Marie Riche
GENEVA.....10 Rue Grenus
Anthony Vandyk

EDITORIAL ADVISORY BOARD
Dr. Peter Castruccio — Alexander Satin
Conrad H. Hoeppner — Dr. Eugen Saenger
Richard F. Gompertz — Robert P. Haviland
Vice Adm. Harry Sanders (ret.)

•

Edward D. Muhlfeld
Publisher

Paul B. Kinney.....Eastern Advertising Manager
Craig L. Mason.....Director of Research
Ron Thorstenson.....Sales Promotion Manager
John N. Carlin.....Director of Circulation
Eugene White.....Circulation Manager
R. Virgil Parker.....Production Manager
Henry Utterback.....Assistant Production Manager
Barbara Barnett.....Production Assistant

Published each Monday with the exception of the last Monday in December by American Aviation Publications, Inc., 1001 Vermont Ave., N.W., Washington 5, D.C. Cable Address: AMERAV.

Printed at Judd & Detweiler, Inc., Washington, D.C. Second class postage paid at Washington, D.C. Copyright 1961, American Aviation Publications, Inc.

Subscription rates: U.S. and Possessions, Canada, and Pan American Postal Union Nations: 1 year $5.00, 2 years $8.00, 3 years $10.00. All other foreign: 1 year $15.00, 2 years $25.00, 3 years $35.00. Single copy prices: regular issues 50 cents each; special issues $1.00 each. Subscriptions are solicited only from persons with identifiable commercial or professional interests in the missile/space industry. Subscription orders and changes of address should be referred to Circulation Fulfillment Mgr. Missiles and Rockets, 1001 Vermont Ave., N.W., Washington 5, D.C. Please allow 4 weeks for change to become effective and enclose recent address label if possible.

THE COVER

Mark W. Cresap, Jr., president of Westinghouse, and E. V. Huggins (right), vice president and director of defense operations, inspect firm's Baltimore Divisions. See p. 12.

NOVEMBER 13 HEADLINES

Electronics Surge: Westinghouse Eyes 'Big Ten' Spot..... 12
Pentagon Liberalizing Space R&D Patent License Setup..... 14
BIOS I Is Nation's First Primarily Biological Shot..... 15
Bad Chimp Shot Would Mean No Manned Orbit This Year 16
Firms Bid for Big Contract of Saturn S-1^b Stage..... 17
Rendezvous R&D May Cost $160 Million in FY 1963..... 18

PROPULSION ENGINEERING*

Excelco Makes Big Solid Cases with Available Know-how 22
Lockheed V-P Cites Cost Arguments for Solid Boosters..... 24
Air Force's New Plasma Lab for Ionospheric Research..... 28
Bell Develops One-man Belt for Weightless Spacemen..... 29

ELECTRONICS

Electrically Suspended Gyro Going into Polaris Subs..... 30
Predetection System to Enhance AMR Data Gathering..... 32

OPTICS

Electro-Optical Perfecting Metal Mirrors for Space..... 36

INTERNATIONAL

Japanese Build New Range for Bigger Sounding Rockets 38

DEPARTMENTS

Letters 6
The Countdown 9
The Missile/Space Week† 10
Technical Countdown 21
Soviet Affairs 37
Industry 42
Names in the News..... 43
Products & Processes 44
Contracts 48
When and Where 49
Editorial 50

*U.S. Reg.

†U.S. Reg. Pdg.

36,814 copies this issue

Sending RAW DATA from MARS!

Unprecedented opportunities are now available for communications engineers and system design engineers at Remington Rand Univac in St. Paul on MARS — the Mobile Atlantic Range Station project.

MARS is a precision tracking system involving the Univac 1206 Real Time Computer and Univac data handling sub system.

From shipboard installation, millions of raw post flight information bits will be transmitted to Cape Canaveral. The career opportunities in working on such a challenging project are obvious, so we urge all qualified applicants to investigate these permanent openings which are now available.

SYSTEMS DESIGN ENGINEERS will be required to develop systems integration procedures between data gathering and data handling systems. Positions include circuit development work and the logical design of high speed computer elements. Engineering, Math or Physics degree with extensive systems experience.

COMMUNICATIONS ENGINEERS should have EE degree, plus 3 or more years heavy experience in high speed, long range digital transmission systems. Experience with missile range information accumulation and transmission valuable. Should have RF experience.

Additional openings are also available for PROGRAMMERS and SYSTEMS ANALYSTS at both St. Paul and a new facility being established in the Cocoa Beach, Fla., area.

Send complete resume of experience and education to:

R. K. PATTERSON

Remington Rand Univac

DIVISION OF SPERRY RAND CORPORATION

Univac Park • St. Paul 16, Minnesota

All qualified applicants will be considered regardless of race, creed, color or national origin.

letters

Stratoscope and OAO

To the Editor:

The article "Stratoscope II to Give Clearest Look at Heavens" (M/R, Oct. 2, p. 28) was very interesting.

Certain of your comparisons between the performance expected from *Stratoscope II* and satellites such as the *Orbital Astronomical Observatory* were incorrect, however.

Balloon-hoisted telescopes do have the advantages, compared with satellite observatories, of low cost and possible high weight of payload.

Satellite observations can be stabilized just as well, however, and probably better than balloon-hoisted observatories. Thus, satellite observatories can get as good or better resolution photographs.

Your article states that "one of the advantages (for *Stratscope II*) not easily duplicated by a satellite observatory (is that) an astronomical body can be studied continuously for a relatively long time—up to an hour."

However, the *Orbiting Astronomical Observatory* will be able to observe any star continuously for at least 63 minutes (over an hour).

Barbara K. Lunde
Physicist, Guidance and Control Section
NASA's Goddard Space Flight Center
Greenbelt, Md.

We are sure that the OAO's will be able to do all of these things—when they are orbited, beginning in 1963. The point is that Stratoscope II is due for launching next summer. The article contrasted Stratoscope II's potential with that of satellites in "today's technology."—Ed.

Further on Lunar Craters

To the Editor:

Mr. Benjamin W. Bova's observance of the ray pattern formed by the impact of a *Ranger* capsule from 1000 ft. to a macadam surface (Letters, M/R, Oct. 9, p. 7) may be analogous to, but not entirely like the ray systems formed by explositivity on the lunar surface.

The ray pattern of the *Ranger* capsule impact is entirely radial, whereas lunar formation, notably Copernicus and Tycho, have several tangential rays. The large ray extending from Copernicus and terminating between Timocharis and Lambert lies at an angle of nearly 90° to the moon's equator and a center line drawn through Copernicus parallel to the equator. An explanation of this phenomenon may be that high-velocity ejecta may have been deflected by resisting materials at or around the site of a meteorite impact, or that the faster rotation of the moon in its early history may have formed the tangential rays by Coriolis action during the flight of ejecta.

The lack of a central peak, common to many lunar craters, but absent in the *Ranger* capsule crater, can be explained by the fact that only specially shaped projectiles form central peaks (so far as we known from laboratory experiments).

The ray systems of certain lunar craters may support their meteoric origin, but to the student of the volcanic origin of the lunar physiography it is doubtful that meteoritic impacts formed all the features of the moonscape. I refer to crater rim peaks with summit pits, internal terracing, polygonalism of crater shapes, domes, meridonal alignment of walled plains (from Walter to Ptolemaus, Furnerius to Langrenus) and concentric craters such as observed in the huge walled plain Boussingault.

Space limits a discussion of these phenomena, but J. E. Spurr's "Geology Applied to Selenology" and V. A. Firsoff's "Strange World of the Moon" should be read by proponents of the meteoritic theory before accepting the popular dogma of the meteoricists.

I should be pleased to see more pictures of ray patterns made by rockets or their components.

Ray Benton
Co-ordinator, Space Research
Exploratory Research Group
Melpar, Inc.
Falls Church, Va.

To the Editor:

In your Oct. 9 issue there was a letter from a Mr. Benjamin Bova which mentioned the puzzle of the moon craters.

I would like to point out that in the August issue of *Scientific American* there was a very interesting article titled "Astroblemes," by Mr. Robert S. Dietz of the Navy Electronics Laboratory in San Diego. The article outlined the possible causes and present appearance of ancient scars left on the earth's crust by huge meteorites.

The "shatter cones" mentioned would, in general, appear to be the same configuration as the "rays" extending from some of the craters on the moon's surface.

Henry Overal
Section Chief, Power Components & Packages
National Water Lift Company
Kalamazoo, Mich.

Bad TV Picture

To the Editor:

The representation of the Cape Canaveral area on the "Brinkley's Journal" (TV) program of Oct. 11 was most unfortunate and in extremely bad taste. It left a poor impression on a nationwide audience, and an improper one.

At a time when it is increasingly important to our national interest to attract the right kind of people to an area where there will be tremendous growth in the years ahead, this program did more to discourage these persons and attract undesirable elements than could possibly have been done had the program been deliberately compiled to accomplish these goals.

What must the rest of the country think of this Cape Canaveral area and of

the enormous expenditures of their tax dollars on activities here when such irresponsible reporting makes this look like a governmental Coney Island, three-ring circus and Disneyland rolled into one—and at their expense.

Of course there are wasted tax dollars here, as in every governmental undertaking, but these are not sudsidizing a playground here as Mr. Brinkley would seem to portray; they are not soaked up as the rains in Florida sand.

An objective, factual, honest survey of ALL facets of life in the Cape area would show the vast—yes, overwhelming—majority of residents to be normal families (look at the growth of schools, shopping centers, churches) who experience the same problems and have the same anxieties as families in almost any other city or town in America.

But we are different here, too. I believe we have a keener awareness of the urgency of the work going on than the nation as a whole. We feel more deeply each advancing step of the Russians in technological progress as we relate this to our known position. This, in turn, kindles a competitive vigor and dedication of purpose to the activities and contributions each of us is making in our own efforts. I believe, too, that we are more sensitive to the meaning of our work, its results, its purpose, its influence on world opinion and reaction, its effect on American prestige than any other collective group in the nation.

George F. Rugge Jr.
Eau Gallie, Fla.

Fitting Survey

To the Editor:

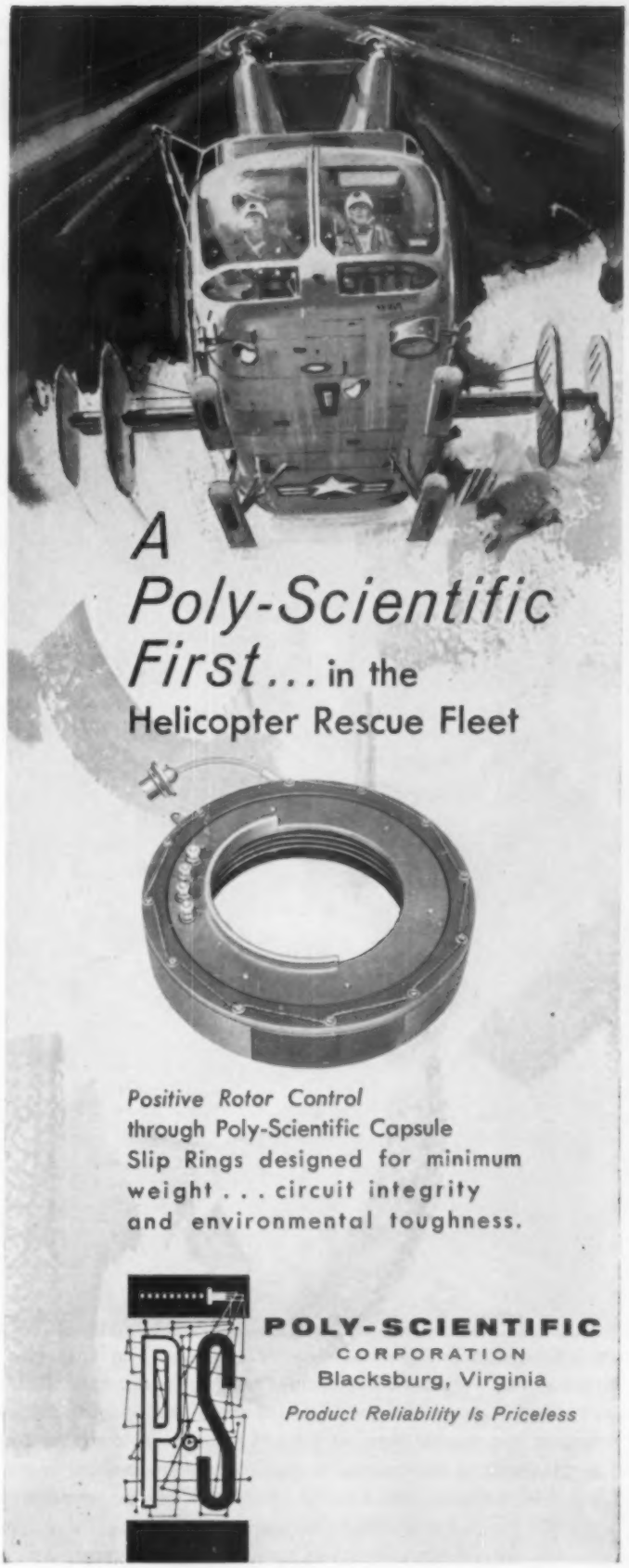
Stanford Research Institute has been designated by Lockheed Aircraft Corp. to survey and evaluate available and potentially available hydraulic and pneumatic fittings.

In particular, on the basis of this survey, we seek to select a suitable tubing fitting for use in missiles and space vehicles. The principal criterion for selection will be the ability to remain helium leak-tight even after exposure to the extreme conditions of ground handling, atmospheric sub-orbital boost and space.

It is our hope that the survey and evaluation will result in the selection of a new fitting to replace the military-standard types in rocket-propelled vehicles. We fully realize that a suitable fitting could be currently in use outside of the missile and aircraft industry, and therefore prior to embarking on a full development program we want to explore all potential areas of availability.

SRI is conducting a general literature survey, contacting all known fitting manufacturers and distributors and following any lead that might result in a new and different type of tubing fitting. We know that reproduction of this letter in your magazine would reach more potential areas throughout the country than all of our survey efforts combined.

Adrien J. Aitken
Propulsion Sciences Div.
Stanford Research Institute
Menlo Park, Calif.



Circle No. 10 on Subscriber Service Card

Do you share his reluctance to accept the accepted?

Doubt is his dogma. He questions everything, takes nothing for granted — not even his own answers.

Do you share his stubborn skepticism? Then come to Northrop, where the breadth and variety of projects give ample scope to the most determined questioner. Northrop's divisional organization makes it possible to support a broad range of programs from countermeasures systems and airborne computer design to techniques for aero-space deceleration and re-entry, and the maintenance of a total human environment in space.

Top priority, just now, goes to senior aerodynamicists and computer circuit designers. But whatever your specialization, if you're the kind of man Northrop needs, there'll always be an opening for you. Why not get in touch with us today and find out more? Just write to Northrop Corporation, Post Office Box No. 1525, Beverly Hills, California.

NORTHROP

AN EQUAL OPPORTUNITY EMPLOYER

The Countdown

WASHINGTON

MRBM: Status Report

The best description of the newly-revived MRBM program to date is: Very tentative. The Air Force has won out over the Army and Navy in receiving a DOD go-ahead to start thinking officially about developing some components. But there is no money, no authority to develop missile prototypes, no decision whether the missile would be sea- or land-based, and no determination whether the NATO countries for whom the missile would be developed will buy it.

Zeus Tests with a Nuclear Punch

One of the hottest reports going the rounds is that President Kennedy soon will announce that *Nike-Zeus* tests in the Pacific next year will involve the use of nuclear warheads. At present, the big Western Electric missile is scheduled to be armed only with HE when it is fired against *Atlases* launched from Vandenberg AFB, Calif. According to various reports, some 12 to 14 nuclear-tipped *Zeus* missiles will be substituted into the test program.

Golovin Report: Will It Stick?

The long-awaited Golovin Space Booster Report is already facing the possibility of rough treatment. A number of government officials who disagree with the report's conclusions are reported to be preparing counter arguments aimed at preventing the report from being used as the basis for final decisions. One of the principal objections comes from NASA officials who are holding out for the *Saturn C-3* rather than the *C-4* called for by the report.

Recovering Saturn

Plans now tentatively call for attempting to recover a *Saturn* booster after the fourth or fifth shot in the R&D launching series. Recovery by parachute—rather than the Rogallo-wing concept—is currently looked upon as the best bet.

Army Pushing for Lead Time Slash

A new drive is being launched by the Army to reduce sharply the lead time needed for development of new weapon systems. One prime feature will be a new system of handling funds to ensure that optimum funding is always possible. This could result in production cuts elsewhere when funding runs low. The goal: Lead times of four years rather than six to eight.

INDUSTRY

R&D Intelligence

The Air Force is reported to be looking into ways to triple the range of *Skybolt* even before the first of the 1000-mi. test models is fired . . . *Snap II* with an output of 2-3 kw will be the power source when NASA tries to fly Electro-Optical Systems and Plasmadyne electrical engines aboard a *Scout*-boosted satellite in late 1963 or 1964 . . . Major snag in the *Apollo* lunar plan still lies in determining what the return propulsion system will be . . . Who Knows Dept. What happened to the West Ford needles?

New United Move In Space

Following up the establishment two years ago of UTC, United Aircraft is now setting up a Corporate Systems Center at Windsor Locks, Conn. Objective: Development, management and production of space and missile systems.

Moving Day for Electrical Propulsion

Electrical propulsion research at NASA is to be transferred from the Marshall Space Flight Center in Alabama to the Lewis Research Center in Ohio. The entire program is expected to be expanded considerably.

Housekeeping Scramble

One of the keenest competitions now in progress is for the housekeeping contract at the big Michoud Arsenal in Louisiana where *Saturn* boosters will be produced. Some 60 companies including a number of the missile/space industry giants are reported to be among the bidders. This may be a new trend in diversification: If you can't build rockets, you can at least serve hot lunches.

INTERNATIONAL

France: Tooling Up for Engines

SNECMA is tooling up for the construction of big rocket engines. The equipment is being installed at the company's Gennevilliers plant. Meantime, SNECMA and SEPR are discussing possible cooperation in the manufacture of the big engines.

Australia: Looking at the Stars

CSIRO—the Commonwealth Scientific and Industrial Research Organization—is putting into operation its huge new radio telescope at Parkes, some 200 miles west of Sydney, Australia. The $1.8-million telescope is only slightly smaller than the famed radio telescope at Jodrell Bank in England. The Parkes telescope's surface accuracy and control system is considered superior.

Overseas Pipeline

Italy's new ASW Center at La Spezia is completed . . . A British *Skylark* reached an altitude of more than 100 miles at Woomera Nov. 2 in the third of four NASA firings . . . Russia is reported to have a new missile with a range of 2000 miles . . . the FAI is revising its "Sporting Code" covering spaceship record flights.

The Missile/Space Week

Justice Scores ComSat Plan

A top Justice Department official declared that an industry proposal for ownership of a communication satellite system did not meet the standards of the Kennedy Administration.

Lee Loevinger, head of the Justice Department's Anti-trust Div., emphasized that dissatisfaction with the proposal was based "mostly on its generalities and omissions."

Loevinger made the statement before a hearing of the Senate Small Business Anti-Monopoly Subcommittee (see p. 14).

He said that the department has not yet taken a stand on details of the plan—which calls for a non-profit corporation to run the system. But in general, he said, the plan was not adequate to meet the requirements set by President Kennedy and the Justice Department.

Loevinger said that one of the areas being studied was the possibility that the plan would give control of the corporation to the American Telephone & Telegraph Co.

Another area needing further study, he said, was one section of the plan which would enable communication carriers to charge off any losses incurred in the system against other segments of their business—including long-distance calls.

Shots of the Week

An "in-orbit malfunction" forced the Air Force to abandon plans for attempting a capsule recovery from *Discoverer XXXIV* after it was orbited Nov. 25. Contents of the 300-lb. capsule in the 1700-lb., 25-ft.-long satellite were not disclosed.

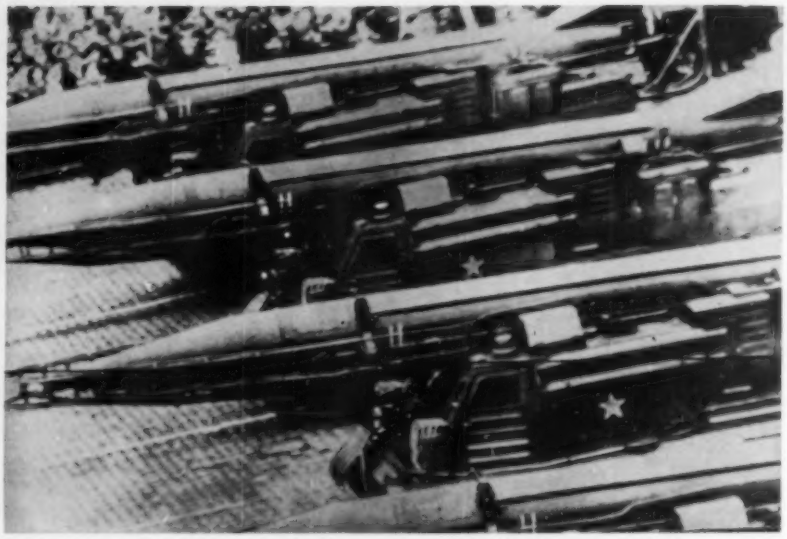
In missile firings:

The Ethan Allen conducted its sixth successful firing of a *Polaris* while submerged on Nov. 8. The 1500-mile A-2 reportedly flew its programed range, the 24th successful shot in 37 submerged *Polaris* firings.

A *Pershing* scored its 21st success in 25 attempts Nov. 2, flying a programed erratic path in a test of the guidance computer system.

At Jackass Flats, Nev., an explosion in a hydrogen system forced cancellation of a full-power run of the Kiwi B-1A reactor Nov. 7. Five men were injured, but the reactor was not damaged.

At Eglin AFB, Fla., a B-52 dropped a dummy *Skybolt* from low altitude. Two others have been dropped from high altitude.



Latest Red Missile Display

SOVIET MISSILES were paraded Nov. 7 on the 44th Anniversary of the Bolshevik revolution. One missile, said to be new, was transported in gasoline-truck-like container The T-5's (above) appeared on tracked armored trucks. (UPI Telephoto)

Reds Join Weather Meeting

Twenty-eight nations are scheduled to attend an International Meteorological Satellite Workshop which will be held in Washington Nov. 13-22.

The Soviet Union—in a surprise move—has announced plans to attend the Workshop co-sponsored by NASA and the U.S. Weather Bureau.

On the first day of the Workshop scientists from both agencies will speak on current weather satellite operations, research results, and plans for the future.

Two days will be spent visiting NASA and Weather Bureau installations including the Goddard Space Flight Center, the data acquisition station at Wallops, Va., the Meteorological Satellite Laboratory and the National Meteorological Center.

In laboratory sessions to be held on November 17, 20 and 21, the participants will perform many practice exercises using actual *Tiros* observations, both photographs and radiation data.

On the final day of the conference, individuals and small groups will have an opportunity to discuss their special problems with experts from both agencies.

The three *Tiros* satellites which have been launched have taken a total of 70,000 cloud photographs. It is U.S. practice to share this information with other countries of the world.

Countries slated to attend the meeting include Argentina, Brazil, Canada, Formosa, Czechoslovakia, Denmark, El Salvador, Finland, France, West Germany, Honduras, Iran, Ireland, Israel, Italy, Netherlands, Antilles, Nigeria, Pakistan, Norway, Poland, Portugal, Sudan, Thailand, United Arab Republic, United Kingdom, USSR, and the West Indies Federation.

New Funding Awards

Several major missile and space programs, including *Titan, Polaris,* and Project *Advent,* received addi-

tional Pentagon spending this week.

An award of $17 million went to Martin's Denver division, for continued development and fabrication of the *Titan* ICBM. Two days earlier, the Air Force spent $10.9 million with Martin for additional R&D testing of the *Titan II*, already in an advanced development stage.

Contracts totaling $13.1 million were let for additional work on the *Polaris*. Westinghouse received $8.1 million for launcher design and development, and a $5-million contract went to General Electric for missile fire control system production.

Project *Advent*, the Air Force communications satellite program being administered by General Electric, was also awarded a $4-million supplemental contract.

NASA Presses Recruiting

NASA has announced that it will visit some 30 cities in its drive to hire some 2000 scientists and engineers by June 30, 1962.

Another 1500 new positions will be filled in administrative and support divisions of the space agency to bring its total employment rolls to well over 21,000.

Administrator James E. Webb noted that the new employees are needed to staff the "lunar program, nuclear propulsion research and development, space science, supersonic transport study and numerous other aeronautical and space technology jobs."

A team of top NASA scientists and officials on one recruiting team visited Chicago last week. Other cities to be visited in the next week include Denver and Phoenix. Other recruiting visits will be announced later.

'Space Club' Pact Near

A nine-nation agreement is expected within the next two weeks on the establishment of Europe's "Space Club."

Governments in Britain, France, Australia, Belgium, Denmark, Netherlands, Italy, Spain, and West Germany are weighing approval of a resolution creating the joint organization for the development and construction of space-vehicle launchers for peaceful purposes. The resolution was drawn up at a London conference which closed Nov. 3. It is still a question whether the three "observer" nations attending the conference,—Norway, Sweden, and Denmark—will decide to participate in the new venture.

Tentative launch schedules, employing much existing hardware and resources to speed initial firings, call for the first three-stage satellite vehicle to be launched from the Woomera range in Australia in 1965. The British *Blue Streak* will be used for the first stage, with France and West Germany providing stages two and three. Initial firing of the *Blue Streak* has been set back to 1963 from a previously scheduled 1962 launch.

Advanced projects are expected to be started soon after the organization becomes operational. A major effort will be made towards development of multipurpose launch vehicles which could orbit an advanced communications satellite. There are no present plans for actual satellite development by the nine-nation group, but approximately $200 million is expected to be spent over the next five years for launcher development, with the British supplying approximately one-third of the funds. The actual satellite may be developed by a new organization or purchased from a U.S. or European supplier.

The "Club" will be headed by a council consisting of representatives of all participating governments, with a secretary-general and a technical director responsible to the member groups for the execution of the various programs.

Red Tests Stop—for Present

Russia touched off its 31st nuclear test explosion—by the AEC's count—on Nov. 4. Premier Khrushchev said more would follow if the U.S. resumed atmospheric tests.

Khrushchev made his statement Nov. 7 after President Kennedy said the U.S. is preparing now for atmospheric tests—if studies show the Soviet series are resulting in military gains.

The Nov. 4 blast was pegged at "several megatons." Two smaller explosions in the low-to-intermediate range were set off in the Novaya Zemlya test area on Nov. 2.

Up to 262,000 counts per revolution
Up to 32,000 counts per revolution
Lightweight Airborne Model Up to 32,000 counts per revolution

DIGISYN®

PHOTOELECTRIC INCREMENTAL POSITION TRANSDUCERS

Performance:

- Digital pulse output from rotary motion input
- Resolution to 262,000 counts per revolution
- Forward and backward rotation counts
- Provisions for zero reset
- Linear & Non-Linear functions

Typical Applications:

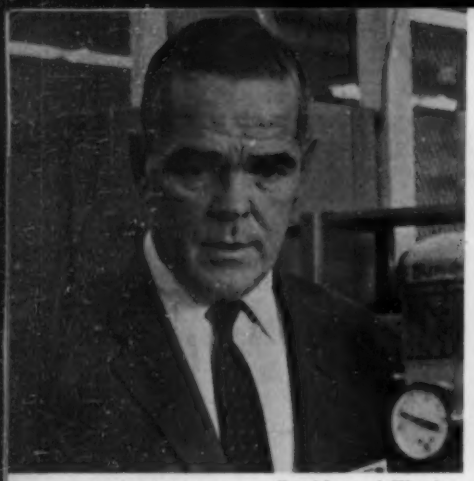
- Precision machines — servo control
- Pulse tachometers
- Shaft position control and monitor
- Circle dividing
- Stable platform position monitor

COMPLETE LINE OF DIRECT-READING BINARY AND SPECIAL ENCODERS AND ACCESSORY EQUIPMENTS ALSO AVAILABLE

Write or call (Boston) COpley 7-8425 for further information

WAYNE-GEORGE CORPORATION
(ADCON DIVISION)
588 COMMONWEALTH AVENUE • BOSTON 19, MASS.

Circle No. 11 on Subscriber Service Card



Mark W. Cresap, Jr.—*President of Westinghouse Electric Corporation.*

E. V. Huggins—*Vice president and director of defense operations.*

Maj. Gen. Albert Boyd (USAF-Ret.)—*Vice president and gen. mgr.-defense products.*

Electronics Surge: 'Big Ten'

Typical of electronics-based firms expanding their missile/space abilities, firm expects 'very rapid' growth in '63-'66

by James Baar

Spot Eyed by Westinghouse

MISSILE and space-based industry is picking up new momentum today amid forecasts that it will reach much greater heights within the next few years.

The lash of requirements from new missile projects and the booming Space Age is forcing further acceleration of the already rapidly moving shift from air frame manufacturing to ever greater expansion and development in advanced areas of electronics, propulsion, power supply and materials.

Of all of these advanced areas the undoubted king-pin is electronics. As NASA Administrator James E. Webb said within the last few days:

"Today approximately 50 cents of every dollar spent for space systems goes into electronics. This ration certainly will not decrease as the accelerated National Space Program advances. . ."

Thus the way is being opened more than ever before for the electronics and propulsion companies to challenge the giant air frame manufacturers for dominant positions in the Missile/Space Industry.

The Big Ten of the Defense Department's List of 100 Prime Contractors already has made room for three electronics firms—General Electric, AT&T and RCA. Others are scrambling up the ladder.

Many of the air frame manufacturers—such as Lockheed, General Dynamics and Martin—are meeting the shift by broadening and reorienting their capabilities. But they find themselves competing in the new areas against firms long established in the field.

As a result, a free-for-all is developing in the market place, and the challengers confronting the Big Ten are making bold advances. Among the foremost are such companies as Westinghouse, Sperry-Rand, Raytheon and General Tire & Rubber.

One look at the Defense Department's List of 100 shows what is happening.

Raytheon has jumped from 22nd in FY '58 to 12th in FY '60. Sperry-Rand jumped from 17th to 13th. General Tire & Rubber (Aerojet-General) jumped from 26th to 17th.

• **Westinghouse ascends**—One of the most powerful challengers for a place in the Big Ten, itself, is Westinghouse Electric Corp. In many ways, this corporation typifies the accelerated shift under way in the industry.

In FY '57, Westinghouse was 22nd on the List of 100 with $182.1 million in prime military contracts. In FY '58, Westinghouse was 18th with $269.3 million in contracts. And in FY '60, Westinghouse climbed to 16th even though the corporation's total prime contracts dropped slightly to $257.6 million—a climb made possible by the continuing decline in aircraft procurement from air frame manufacturers.

The Defense Department's list for FY '61 has not yet been issued. However, Westinghouse's prime contracts for the year rose to about $308 million, indicating another jump on the list.

Westinghouse officials feel that this climb has only begun. As Mark W. Cresap, Jr., Westinghouse's driving 51-year-old president, put it recently:

"We have had a plateau of net sales since 1957—about $1.9 billion to $2 billion a year. We expect these to begin to rise at a very substantial rate in about another 12 to 18 months. We expect the period 1963 to 1966 to be one of very rapid growth for the corporation."

Cresap sat in a paneled office of the new administrative wing of the Westinghouse Baltimore Divisions. E. V. Huggins, chairman of the corporation executive committee, vice president and director of all Westinghouse defense operations, and Maj. Gen. Albert Boyd (ret.), vice president and general manager of the Westinghouse Defense Products Group, were with him.

They had just completed a periodic meeting with officials of the Baltimore plants and were about to tour the facilities. Among other programs, the Baltimore Divisions handle the nuclear-tipped *Astor* torpedo and

(Continued on page 40)

Pentagon Revamping Patent License Policy

Industry will have far greater use of inventions that result from space R&D; ComSat ownership still studied

THE DEPARTMENT of Defense is making a major change in its patent licensing policy in all space research and development contracts.

The change will permit far more extensive use by American industry of new inventions and devices developed under DOD contracts.

The new move was disclosed at a hearing of the Senate Small Business Anti-Monopoly Subcommittee called to take testimony on the ownership of a commercial communication satellite system.

Kennedy Administration officials declared that no "government-wide" position will be taken until the Federal Communications Commission completes its study of recommendations made by an ad hoc committee of international communication carriers. They indicated, however, that Administration leaders will probably propose changes in the carrier's plan for a non-profit corporation to run the system.

• **Sublicense authority**—The DOD patent policy switch results from a study by the White House's National Aeronautics and Space Council.

Dr. Edward C. Welsh, Executive Secretary of the group, told the congressional committee that although the patent policy dealt principally with communication satellite R&D contracts, DOD had agreed to extend it to all contracts in the space field. It is also probable, informed sources report, that the policy will govern many other DOD contracts in the R&D area.

Under previous DOD policy, the private firm awarded a contract was also given an exclusive license to use any patents developed during its performance.

According to the official language of the new policy, the contractor will also "grant the government the right to grant sublicenses to others, under such terms and conditions as may be prescribed, for the practice of any subject invention throughout the world in the design, development, manufacture and operation, maintenance and testing of communication satellite systems, and of equipment, components, ground tracking, transmitting and receiving facilities therefor."

In addition, Dr. Welsh told the committee, DOD has advised that such language will be included in all future contracts covering research and development in any field related to space, including space exploration and space communications.

The DOD policy on space patents will now be much closer to the NASA policy. The space agency has proposed, however, it be permitted to charge sublicensees a "fee" for the use of a patent developed by another firm.

• **Ownership evaluation**—As far as the ownership plan for a commercial communication satellite system is concerned, Dr. Welsh said "no definitive administration position can be presented until studies of the ad hoc committee's proposal are completed by government agencies.

"When we do have such an evaluation finished," he continued, "it presumably would take the form of a recommendation to the President."

The carriers' report called for a nonprofit corporation to be set up to run the system. Its board of directors would be composed of representatives of the communication carriers contributing funds and using the system, together with three representatives who would be appointed by the President.

Under this plan, American Telephone & Telegraph Co. would contribute about 80% of the costs of the whole system. Government officials believe that this would put AT&T in effective control of its operation. A final government position will not be decided until after the FCC holds a public hearing in which sworn testimony will be taken from witnesses representing all sides of the thorny issue.

• **Plans afoot** — Meanwhile, there were these other developments in the communication satellite field:

—Radio Corporation of America declared that a communication satellite capable of relaying television programs directly to home receivers is now feasible.

—Lockheed Missiles & Space Co. has proposed to NASA a plan to launch three 600-lb. real-time repeater communication satellites into a 22,300-mile synchronous orbit.

RCA said that its proposed system could be developed and put into operation by the end of the decade at a total cost of $400 million. The system would be able to retransmit television programs over a whole subcontinent, such as India; it is believed that this would open up a vast channel for mass communications and education in underdeveloped countries.

Satellites being developed for government and industry for use in the middle of this decade would be capable only of relaying television programs between stations but not directly to home receivers.

Under the RCA plan, the satellite would house a miniature powerplant capable of relaying the television signals with enough power to be received by ordinary home receivers.

The satellite would be powered by a *Snap* device—a compact reactor powerplant being developed by the Atomic Energy Commission — which would generate up to 60 kilowatts of electricity for use in satellites.

During the launching, some of this power would be used to drive an electrical propulsion system that would gradually elevate the satellite to a 22,300-mile-high orbit.

From this orbit, the satellite would be able to transmit television directly to home receivers in an area of 1 million to 3 million square miles.

The Lockheed proposal is designed to provide synchronous communications satellite system which would not be capable of transmitting to home receivers.

Total cost of its proposal is estimated at $25 million. It calls for the use of an *Atlas-Agena B* launch vehicle with a solid-propellant third stage. ⌗

Using Nerv capsule . . .

BIOS First Primarily Biological Shot

Seventeen experiments aboard modified GE craft to probe weightlessness, radiation, g-forces

by Heather M. David

THE FIRST U.S. project to be devoted primarily to biological experiments in space is scheduled to be launched by NASA November 15 from Pt. Arguello, Calif.

BIOS I, containing some 17 experiments will be an adapted General Electric *Nerv* capsule. Since the original *Nerv* shot was so successful, only one of six capsules was used. GE modified the remaining capsules for intricately engineered biological experiments at a cost of $523,000.

Wednesday's shot is to duplicate the *Nerv* shot in every way—altitude, distance and general radiation conditions. Barring a solar storm or a malfunction of the vehicle, radiation data obtained on the *BIOS* shot will be comparable to those of *Nerv*. In addition, the time will coincide with a predicted meteorite stream.

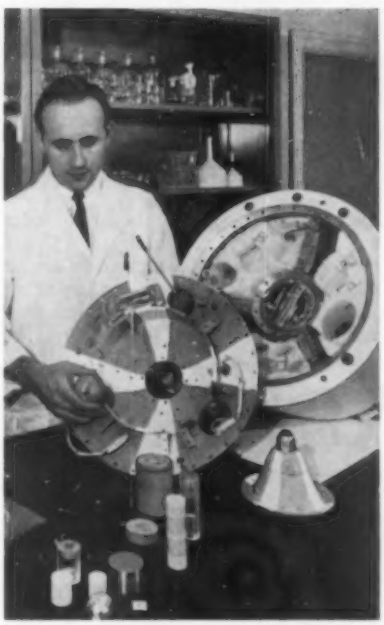
Should the vehicle malfunction, NASA has a backup capsule and booster which would be ready to go within 48 hours.

Like *Nerv*, the capsule will be boosted by an *Argo D-8* to an altitude of 1165 miles—highest know for a U.S. project. The rather steep trajectory carries it a little over 1000 miles down the Pacific Missile Range.

• **Objectives**—The experiments are designed to determine the effects of weightlessness, radiation and high acceleration. They will be exposed to about 25 minutes of weightlessness, accelerations of about 80 g's because of the acute re-entry angle, and Van Allen belt radiation and micrometeorite conditions.

Radiation will be measured by a nuclear emulsion pack mounted on a retractable cylinder. The cylinder will extend after launch, the emulsion pack will revolve one time, and retract before re-entry. The apparatus was designed by Donald A. Kniffen of Goddard.

Devices aboard the capsule will also collect micrometeorite material and record impacts. Otto E. Berg of Goddard is responsible for this portion of the probe.



BIOS I capsule with 17 experiments weighs 88 lbs., is 17 in. long, 19 in. in diameter.

• **Weightlessness experiments**—The *Nerv* capsule was modified to hold some 38 capsules containing material for 17 experiments. Although of a basic nature, each experiment will provide knowledge of how space flight will affect man's basic life processes. The experiments were administered by NASA's Goddard Space Flight Center and Ames Research Center.

One experiment, conducted by General Electric MSVD scientist Dr. Richard W. Price, will indicate whether single cells will "eat" (be nourished) during weightlessness. If research shows that they cannot, it may ultimately lead to allowing man to undergo only short periods of weightlessness, or rotating space vehicles. If, on the other hand, cells do feed normally, any future loss of weight in astronauts can be attributed to some other cause.

Two small capsules will contain quantities of amoebae, food (paramecium) and a lethal agent, formaldehyde. The amoebae are separated from the food until weightlessness. After weightlessness, they are killed.

Immediately after the vehicle is recovered, the dead specimens will be examined on board the recovery ship by another GE scientist. If the amoebae show food particles, it will prove that weightlessness does not hinder this natural process.

In spite of the extremely high g forces during re-entry—up to 80—Dr. Price said that he does not anticipate a disturbance due to accelerations. Intensive experimentation conducted upon centrifuges shows that cells appear to function normally under this stress. In fact, the GE group has subjected amoebae to as much as 500 g's without change in their habits.

A second GE experiment designed by Dr. Donald R. Ekberg calls for much the same equipment—but the amoebae are recovered alive. By studying the chromosomes in the nuclei, and the ratio of the nuclei to the cytoplasm, Dr. Ekberg will determine whether the external influences brought about any change in the normal growth pattern. The experimenters will also stain the recovered cells to find any alterations in cell chemistry.

The significance of this type of experiment, according to Dr. Price, is that it reduces life processes to the basic level and eliminates any compensatory reaction of the whole organism. Thus, each process can be studied separately.

Florida State University researchers have contributed an experiment to investigate "production of microspheres at zero gravity." This deals with the effect of zero g on fluids, of which human cells are mostly composed.

A sea urchin test will help to show

(Continued on page 37)

Chimp Readied for Three-Orbit Flight

Successful Mercury launch won't necessarily result in manned orbit this year

by Hal Taylor

SOMETIME in the next few days, NASA will attempt to rocket a medium-sized chimpanzee in a *Mercury* spacecraft into a three-orbit ride around the earth.

NASA officials said that the earliest possible date for the flight of *MA-5* is Nov. 14. Even if the shot goes right on schedule and is executed perfectly, the space agency will still be hard-pressed to achieve a manned orbital flight this year. If there is any delay or technical problems, the possibility of putting the first American astronaut into orbit this year is out of the question.

MA-5, with its chimp passenger, will be boosted into an orbital path of 32 degrees by an *Atlas D* launch vehicle. The orbiting phase of the mission will last approximately 4½ hours at altitudes ranging from about 100 to 150 statute miles.

If the flight proceeds as planned, during the third orbit, as the craft approaches the West Coast of the U.S., the retrorockets will be fired to initiate re-entry.

The spacecraft will begin to enter the atmosphere approximately over Florida and will experience maximum deceleration and re-entry heating at an altitude of about 37 miles. Touchdown and recovery will be about 800 miles southeast of Cape Canaveral.

ABOVE: *Sketch of the planned trajectory for first three-orbit flight of Mercury capsule.*

BELOW: *One of NASA's prospective orbiting chimpanzees is fitted in his form-fitted plastic couch with restraining net harness.*

• **First three-circler**—The flight will mark the first time that the *Mercury* spacecraft has been launched on a three-orbit mission. Its chimp passenger—one of five trained for orbital *Mercury* flights by the Biastronautics Research Laboratory at Alamagordo, N.M.—is being included to prove the adequacy of the spacecraft's various life support systems for a three-orbit mission.

The chimp will ride in a fully operational, specification Environmental Control System (ECS). It will be encased in a pressure-tight metal and plastic box which is connected into the ECS suit circuit in the same manner that an astronaut's suit would be. The animal will be restrained in a form-fitted fibrous plastic pallet by a net harness.

A minor modification has been incorporated into the system to preclude the possibility of excessive oxygen consumption such as occurred during the previous *Mercury* orbital flight.

Postflight investigation of *MA-4* revealed that launch vibrations caused the manual handle controlling the emergency oxygen system to open slightly, thereby allowing higher oxygen flow into the "mechanical astronaut" than was necessary.

Reactions and condition of the chimp during the flight will be monitored and reported by on-board cameras and telemetry.

He will be riding in a livable gaseous atmosphere of 100% oxygen maintained at a comfortable room temperature and a pressure equivalent to 27,000-ft. altitude.

• **Treats for Tricks** — A shelf at waist level of the animal has been equipped with three levers and three displays of geometric symbols (simple triangles, squares and circles).

Each psychomotor problem will call for two of the displays being identical—the third odd. The animal will respond correctly by depressing the odd lever under the odd symbol—and when he does will be rewarded with a banana-flavored wafer, slightly larger than an aspirin.

It will be provided through a dispenser on the shelf. Wafers are provided to reward 100 per cent correct responses. Five cc's of water will also be offered.

Each time the animal depresses a

lever, the symbols are shuffled. Improper selection of the odd symbol when a problem is presented will result both in the denial of reward and application of a mild electrical shock, administered through the animal's left shoe.

• **Close watch**—Throughout flight, the primate will be photographed by the same camera installed for manned flights; however, it will be shooting through the plastic cover of the pressurized couch. Following flight, an attempt will be made to correlate the appearance of the animal and his state of awareness—i. e. fear, relaxation, drowsiness, sleep or unconsciousness.

Further indication of the animal's condition will be provided by telemetry. Signals emanating from the spacecraft during flight will provide medical monitors at worldwide tracking stations with a running report on the animal's heart rate, blood pressure, respiration and body temperature.

• **Familiar capsule**—The *Mercury* spacecraft used in *MA-5* will be very similar to previous capsules utilized in the *Mercury* program.

It will have a large "picture window" viewing port. Previous *Mercury* spacecraft had two small porthole windows instead of one large window.

It will also have fully operational, specification controls—both the Automatic Stabilization and Control System (ASCS) and the Rate Stabilization and Control System (RSCS).

The latter system provides an alternate means of spacecraft control in the event the ASCS should malfunction. The manual system has not been included, since it is not needed for an unmanned flight.

MA-5 will provide a further test of a quick release explosive escape hatch which malfunctioned during the second manned *Mercury* suborbital flight.

Four separate camera systems will be carried in *MA-5*. A 16 mm primate observer camera situated on the main instrument panel will photograph the animal throughout the mission until near the time of landing. The camera is to the left of the periscope.

A second 16 mm camera, near the couch, will film the spacecraft instrument panel, providing coverage throughout the mission and for about three minutes after landing. Another 16 mm camera will film the field of view seen through the low magnification of the periscope. The camera will operate for about 2.8 hours following orbit insertion.

A 70 mm earth-sky camera will provide coverage throughout the mission of the view seen through the spacecraft window.

Recovery of the chimp and the spacecraft will be by helicopter. ⌗

Billions at Stake . . .

Five Companies Bid For Saturn S-1B Contract

FIVE missile/space industry firms submitted proposals last week on the S-1B first stage for NASA's planned second-generation *Saturn* superbooster.

The competitors are Martin, Aerojet-General, Space Technology Laboratories, General Dynamics/Astronautics and Boeing. NASA said more bids may have been mailed in.

The firms are bidding on a developmental and production contract for the stage which eventually may be worth billions of dollars. Under the current plan, the vehicle will be designed by the Marshall Space Flight Center. NASA is currently preparing launch facilities for the vehicle, which will be capable of 30 launches per year.

NASA has not yet made an official decision as to just how many engines and what total thrust the stage will have. The Golovin Committee has recommended that the stage have four F-1 engines developing 6 million lbs. total thrust. Many top officials at NASA headquarters still support a two-F-1-engine version and are trying to convince Administrator James E. Webb of the correctness of their position. It is almost certain, however that the Golovin Committee view will prevail.

• **Missions**—Current plans for the S-1B stage call for its use to send a three-man *Apollo* spacecraft into orbit around the moon. It will be used for earth orbital flights with the spacecraft.

It is also slated for use as the prime vehicle for manned lunar landings using the orbital rendezvous concept. This would be a two-shot affair, with the second lifting a propulsion module into orbit to be mated with the *Apollo* spacecraft for the moon roundtrip.

The NASA announcement said that the bids will be evaluated and a contract will be awarded in December.

• **S-1 bids weighed** — Meanwhile, the space agency is continuing its study of bids on the S-1 stage of the *Saturn* C-1 booster.

This stage — which was launched successfully on Oct. 27—will have eight H-1 engines with a total stage thrust of 1.5 million lbs. This contract will be awarded late this month and signed sometime in December.

Seven firms — Chrysler, Boeing, Ling-Temco-Vought, Ford Aeronutronic, Avco, Northrop, and Lockheed—are bidding for it.

The C-1 will be used to orbit boilerplate models of the *Apollo* spacecraft and eventually—when its upper stages are developed—will be able to launch three-man capsules in earth-orbiting trips.

Both launch vehicles will be built at the Michoud, La., plant which NASA recently took over.

Production of both stages will take place simultaneously with work on the C-1, expected to begin early next year. The first C-1's are expected to roll off the assembly lines in late 1963, with C-4 production expected to provide its first complete booster ready for launch in late 1964 or early 1965.

The *Saturn* C-1's will be launched from three pads at Cape Canaveral. One pad, Launch Complex No. 34, was used for the first launch of the vehicle. Launch Complex 39—which will have two pads—will be completed in 1963. About $20 million has already been expended for the construction of the pad.

Construction of Launch Complex 39—from which the S-1B stages will be launched—will begin early in 1962.

• **Space station study**—In another development, NASA announced the award of a $95,000 contract to North American Aviation Co. to study the technical feasibility of a large erectable manned space station.

The station would be based on a concept which originated at the NASA Langley Research Center.

Purpose of the study is to identify critical problem areas, establish methods of problem solutions for each of the areas, determine the state-of-the-art advances required in each problem area, and determine the areas where additional or intensified research will be required to delineate a sound research program.

The space station concept has for several years been a subject of basic study by Langley scientists, who conduct theoretical and experimental research on structures, materials, dynamics, and thermal balance.

The aim of this research is to provide a background of technical information necessary for the design of manned orbital laboratories.

The space agency said that any advances in knowledge achieved by Langley's research program are applicable to space stations in general as well as to manned lunar and planetary vehicles. ⌗

In Fiscal Year '63 . . .

Rendezvous May Cost $160 Million

by William Beller

NEW COMPUTATIONS by NASA indicate upward of $160 million may be spent in FY '63 to launch a major R&D program for orbital rendezvous.

The expected big jump in spending is understood to stem from the soon-to-be-revealed recommendations of the Golovin Committee, which has indicated that rendezvous may be the quickest way for the U.S. to beat Russia to putting a man on the moon (M/R, Oct. 9, p. 16).

The lion's share of the money probably will go into developing a test rendezvous between an unmanned *Mercury Mark I* capsule and an *Agena B* rocket, a key NASA official told MISSILES AND ROCKETS this week.

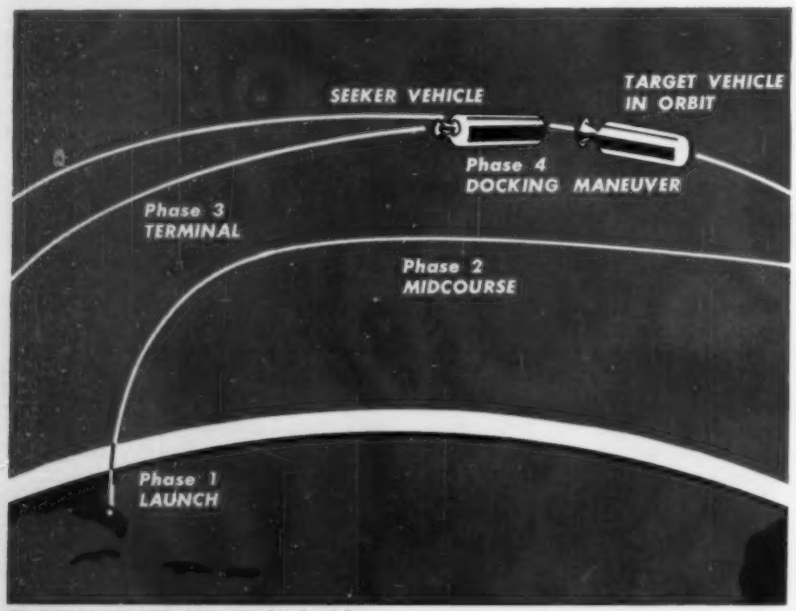
Another segment of money is earmarked for developing a simulator to train astronauts in rendezvous and docking techniques.

• **The billion-dollar pad**—The concept of a direct flight to the moon via a *Nova* or *Super Nova* is being downgraded. Expense is one of the main reasons.

It is estimated that a *Super Nova* pad would need three million pounds of concrete. The LOX facilities needed to fill the *Super Nova* would be bigger than the combination of all the LOX facilities that are on all the missile bases in the U.S. With all GSE facilities, the *Super Nova* pad would cost about $1 billion.

DRAWING of rendezvous mission simulator.

NASA committed during Fiscal Year 1961 a little less than $1 million for orbital rendezvous studies. Administered by the Marshall Space Flight Center, the work was spread among many qualified contractors and universities in order to get a broad spectrum of talent and opinions.



SUCCESSIVE PHASES of orbital rendezvous.

To continue its rendezvous studies during Fiscal Year 1962, the space agency asked Congress for $2 million, which was upped to $8 million. Thus, the anticipated oncoming funding for rendezvous is 20 times greater than that Congress recommended for FY 1962. And indications are that it will continue to rise.

The rendezvous or space-station technique has wide potential uses:

—A jump-off point for a lunar mission.
—Military offense and defense.
—Assembly of interplanetary expeditions.
—Refueling operations.
—Repair operations.
—Space crew relief and rotation.
—Crew safety in major launchings.
—Crew rescue.

Here are some of the problem areas that must be looked into before orbital rendezvous can take place:

• **Tracking**—A precise ephemeris of the target satellite must be known. If the satellite is in radio contact with its tracking station, then it's no problem to derive the vehicle's motion to the needed accuracy after a few orbits.

But if the satellite is "non-cooperating" and silent (electronically dark), it must first be found and its path calculated by our "dark fence" detection system and its computers. This might call for considerable enhancement of "dark fence" capabilities, particularly if the target is to be picked up on its first few orbits around the earth.

• **Power control**—To intercept the target and then go through the docking maneuver with its "inching" requirements, the rendezvous vehicle should have throttling control over its engines. The degree of flexibility needed has been compared to the control a driver needs over his car when he's backing into a tight space.

These requirements suggest using restartable, liquid-fueled engines of the throttleable type. Small solid rockets might also be used as an adjunct, because of their simplicity and reliability. For the final docking phase, the exhaust from gas bottles might be used for vector control.

Where sustained operations are called for, the choice would narrow down to some form of electric propulsion.

(Continued on page 42)

NOTICE TO SUBSCRIBERS

This card is not a renewal notice. It is for the use of new subscribers only. If you already subscribe, please pass this information on to an associate in the industry.

Receive your personal copy of missiles and rockets every week

Examine this copy of **Missiles and Rockets,** The Missile/Space Weekly. You will quickly see why M/R is relied upon by subscribers for fast-breaking news stories and complete technical editorial coverage of electronics, guidance, propulsion, advanced materials, ASW and ground support equipment. If you are not now a regular subscriber, it will pay you to have your personal copies of M/R delivered regularly to your home, office, or laboratory on a weekly subscription basis.

FILL OUT AND DETACH CARD BELOW. CARD MUST BE FILLED OUT COMPLETELY BEFORE YOUR ORDER CAN BE PROCESSED.

ENTER MY [NEW] *SUBSCRIPTION TO*

missiles and rockets

☐ **3 YEARS $10**
☐ TWO YEARS $8.00
☐ ONE YEAR $5.00

ALL SUBSCRIPTIONS TO MISSILES AND ROCKETS INCLUDE THESE SPECIAL ANNUAL ISSUES:

March
Research and Engineering Issue

July
Missile/Space Encyclopedia Issue

November
National Aeronautics and Space Administration Issue

Please indicate your principal field of work :

- ☐ Missile frame
- ☐ Power plants
- ☐ Support systems
- ☐ Components
- ☐ Consultants, R&D
- ☐ Missile base/range operations
- ☐ Propellants
- ☐ Metals, Materials

CHECK ONE BOX ONLY

Rates shown above are for U.S., Possessions, Canada and Postal Union Nations. *Other countries:* ☐ 3 years $35 ☐ 2 years $25 ☐ 1 year $15

☐ Send bill later ☐ Check enclosed ☐ Purchase order attached

NAME _____

TITLE OR POSITION _____

STREET ADDRESS _____ ☐ *HOME?* ☐ *BUSINESS?*

CITY _____ *ZONE* _____ *STATE* _____

COMPANY NAME _____

DIVISION _____

11 - 61

Subscriptions are limited to those in the missile/space industries or in related areas. Please fill out this card completely. Additional postage is required if mailed outside the U. S. A.

These missile engineers already know the value of missiles and rockets . . .

"I want to keep up with the industry in which I am engaged. This publication contains information that I do not get elsewhere."

—Analytical Engineer, Rocket Equipment

"I like the magazine. It is different; it covers everything in as few words as possible."

—Engineer, R & D, Missiles, Radar Communications

"It keeps me up to date on new developments. All the information is condensed and you do not have to wade through a thousand pages to get a nickel's worth of information."

—Project Manager, Consulting Engineers

FIRST CLASS
Permit No. 2455-R
WASHINGTON, D. C.

BUSINESS REPLY MAIL
No Postage Stamp Necessary if Mailed in the United States

POSTAGE WILL BE PAID BY

missiles and rockets

THE MISSILE/SPACE WEEKLY

1001 Vermont Avenue, N.W.,
Washington 5, D. C.

Technical Countdown

ELECTRONICS

Guidance Needed for Range Increase

The only way *Asroc* range can be effectively increased beyond its present 8-mile limit is with the addition of a guidance system, a Minneapolis-Honeywell official said recently. *Asroc* is the Navy's surface-to-underwater solid-rocket torpedo (or depth charge). M-H is prime. The idea has been considered by the Navy, but informants say that as of now there are no official plans to effect such a change in the weapon system.

Radar Anti-jam Potential Grows

New multi-megawatt power amplifier tube developed by Sperry-Rand could greatly enhance radar anti-jamming characteristics in future systems. Called the Meanderline traveling-wave tube, it broadens frequency bandwidths of radars to about 30%—that is, at a frequency of 3 gc, steady amplification could be achieved from 2.55-3.45 gc. This is several times wider than ranges of existing radars. In time, Sperry scientists say megawatt power amplification will be possible over even greater bandwidths, such as from 5-10 gc.

Tiddle Tests Terminate Successfully

Air Force Systems Command says it has successfully proved its new Time Division Data Link (TDDL) for multiple missile/aircraft defense commands. Nicknamed Tiddle, a single multiplex communications system was used in the Experimental SAGE Sector at Hanscom Field, Mass., to issue multiple commands simultaneously to interceptor aircraft. It will be employed also with *Bomarc-B* surface-to-air guided missiles, the Air Force said. *Bomarc* tests using Tiddle were performed over the Gulf Test Range from Eglin AFB.

British Plan Massive Show

The biggest international electronics show ever held in Britain will be the London International Engineering Exhibition, organizers say. To be held at Olympia and Earls Court, April 23-May 2, 1963, the 10-day exhibition will require all of the 1 million sq. ft. available in both buildings for an estimated 12,000 exhibitors. With Britain's current negotiations to enter the Common Market, it is no accident that this "biggest of all shows" will overlap the Hanover Fair in West Germany.

ASTRONAUTICS

Navy Rocket Gathers Detailed Solar Data

An *Aerobee-High* rocket launched from White Sands Missile Range in August photographed the solar spectrum in about ten times more detail than the best previous experiments, according to scientists of the Naval Research Laboratory. Using an Echelle grating, the experiment resulted in about 5000 spectral lines in the range from 3400 A to 2150 A. The Navy says this is the first extreme ultraviolet solar spectrum obtained that compares favorably in resolution with solar spectra in the visible light range.

Dyna-Soar Abort Thrust Halved

Thrust requirements have been cut in half for *Dyna-Soar I* separation from booster during early launch period. (There is a short period immediately after launch during which it is possible to separate and recover the hypersonic vehicle.) Abort and recovery techniques have been developed by NASA pilot Neil Armstrong, using an F5D aircraft at Edwards AFB. Flight studies are believed applicable since the F5D, under certain conditions has a lift-to-drag ratio approximating that of *Dyna-Soar* (0.4-0.5).

SUPPORT EQUIPMENT

Falcon Monitors Being Built

Under contract from the Air Force, Hughes Aircraft Co. is building four airborne recorders to monitor the operational performance of the armament control system used with the GAR-11, *Falcon*, air-to-air missile. Designated TARP for Tactical Airborne Recording Package, the system consists of an oscillograph recorder and eight plug-in extensions to detect armament control problems as they occur in the air. Armament-system response will be printed on sensitive paper for later evaluation on the ground.

Helicopter to Carry Pershing Tested

A new medium tactical transport helicopter—capable of airlifting the Army's *Pershing* missile system—was flown for the first time last month, according to Army officials. Nicknamed the Chinook, it is powered by two Lycoming T-55 engines which give it a cruising speed of 150 mph and a range of some 200 miles. The Army expects to accept first deliveries late this year. Payload capacity of the 'copter is estimated at approximately 7 tons.

ASW & SEABORNE ENGINEERING

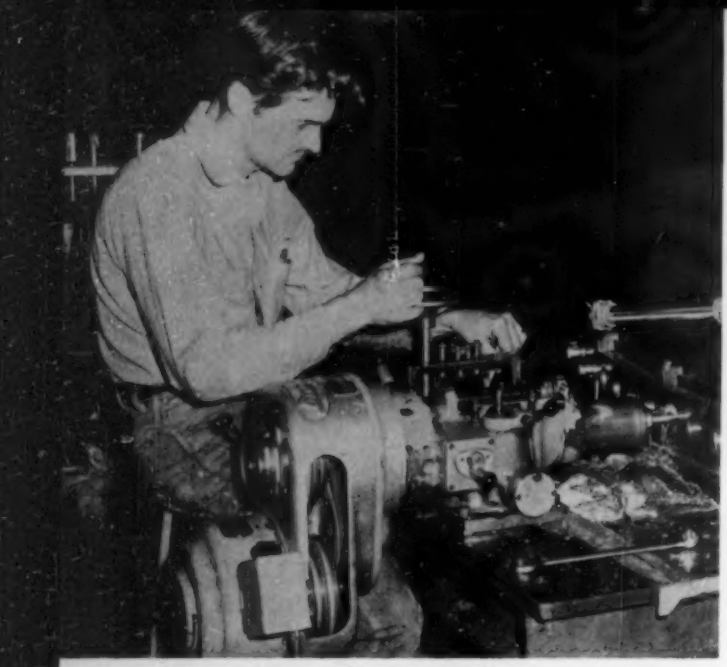
Russians Build Commercial Hydrofoil

Capitalizing on the commercial potential of hydrofoil ships, the Russians have built an operational hydrofoil craft capable of carrying 150 passengers at speeds up to 40 knots. The ship—called the Meteor—is the forerunner of a larger craft, the Sputnik, which will be able to carry 300 passengers at speeds of 50 knots. (The HS Denison will be this country's first entry into the commercial hydrofoil field. According to its developers, Grumman Aircraft Engineering Corp., this ship will be capable of speeds of 60-80 knots.)

ADVANCED MATERIALS

Largest Quartz Lens

A huge quartz lens weighing 350 lbs., ground to the tolerances of microscope lenses by Bausch & Lomb, will be part of an optical solar simulation system at Jet Propulsion Laboratory. The system will be housed in a seven-story environmental chamber costing some $4 million. The 3-ft. lens will focus radiation from source optics into a "virtual source" of radiation within the vacuum portion of the chamber. This virtual source collects and scrambles all the radiation from all the high-intensity Mercury-Xenon lamps and reflects it onto a huge, nitrogen-cooled, parabolic reflector. This unit, in turn, reflects the radiation in parallel beams onto the test plane containing the test vehicle.



HOLES for the tapered pin joint are drilled with this simple rig.

propulsion engineering

Big Booster Cases—

Excelco's approach is to utilize solid case techniques already available, avoid sophistication; firm makes huge chambers

by John F. Judge

SILVER CREEK, N.Y.—A veteran solid motor case fabricator says the U.S. should get moving in the large booster area with available techniques and knowledge—"then refine as you go along."

"If the White House really wants to beat the Russians to the moon," says Leroy Brooks, president of Excelco Developments Inc., "then let's play the game and take the risks. When you're behind and time is running out, you don't play it safe if you want to win."

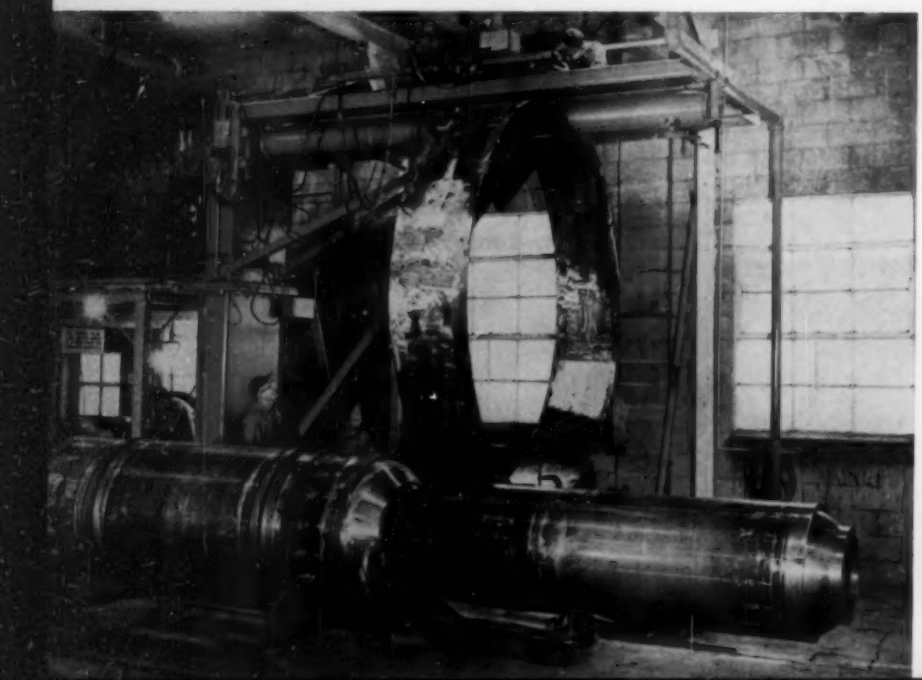
Brooks feels that the initial stages of the large solid program should follow the *Polaris* approach in the pressure chamber area—use anything that works and forget sophistication. This saves time, and in the long run, money.

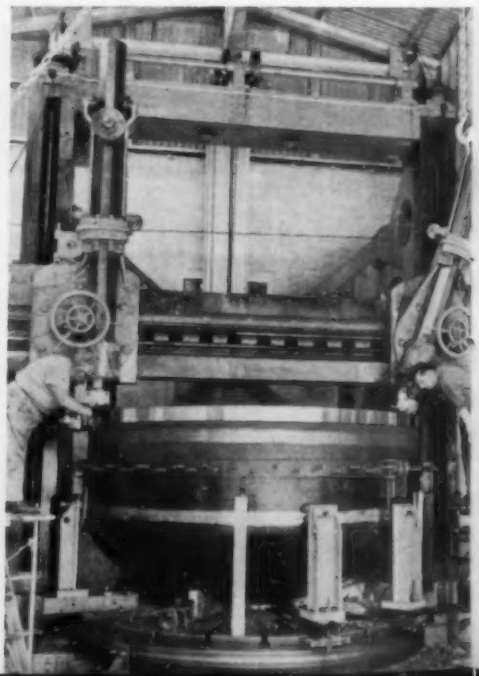
• **R&D motors?**—Excelco is not a production shop, yet more solid cases have been built here than anywhere else in the country. The firm turns out development cases for many ground tests necessary in perfecting solid motors. In spite of this, most of their motors have flown in a number of programs close to, or actually in, operational status.

Brooks is currently fabricating the largest solid chambers to date—120-in. diameter cases for Lockheed Propulsion Co., (formerly Grand Central Rocket Co.) experimental booster. The huge vessels are formed in three sections joined by a Lockheed Propulsion-designed tapered pin arrangement.

Cylindrical sections are rolled and welded into rings, then circumferentially welded to form segments. The equipment at Excelco is geared to handle anything up to 168-in. diameter.

The large booster is a brand new area of case manufacture. Almost all previous experience in the U.S. has been with thin gage material. Some sections of the Lockheed case—rough machined before heat treat—are 3 in. thick. Brooks says this alone is an aspect that demands study and the ideal methods for heat treating operations for such varying thicknesses have yet to be determined. This can be achieved only through experience in working with





Build Them Now, Refine Them Later

the desired design item.

• **Furnace lead time**—The Lockheed cases are currently heat treated in the large 120-in. furnace at General Electric's Evendale facility—the same unit used in the *Minuteman* motor case program at that firm. If the proposed 160-in. case is specified, then a larger heat treat facility must be built and the best estimate from go-ahead to completion is 9 months. But Brooks says its location cannot be determined until big booster contracts are placed.

The 120-in. case marks the end of the single piece head. The 160-in. cases being proposed will have to use multi-piece end enclosures. The reason is simple—there are no heavy presses in the U.S. large enough and the biggest steel plate rolling mill is limited to around 170-in. square blanks.

Multi-piece heads pose no real problem to Excelco. They have been using them when the occasion demanded it for years.

Excelco's versatility is a product of experience. In the Lockheed program, large boring mills are used as lathes. Welding is an automatic two-step operation — first an outside weld running about half-way through the workpiece, then a second weld from the inside. The first weld is ground and X-rayed before the second operation commences, and any necessary repairs are made. Another X-ray follows the second welding process. Brooks is quite positive his cases will do the job and hydro-static tests back him up.

"Large cases can be built in about twenty different ways", says Brooks, "and there is too much procrastination." The outspoken fabricator feels that too many people with too many ideas and too many specifications get into the early phases of most programs and the end result is "too much confusion" and "too much delay."

Excelco knows exactly how they would approach the big cases. They would move with whatever is available, similar to the current 120-in. work.

The firm has been in many programs. It actually started out fabricating the liquid fire thrust chamber for the Hermes program and got into the first large, thin-wall, solid propellant program as a feasibility study along with the Hermes. These cases were known as the RVA 10 (Research Vehicle A-10) and were the first large solid rockets fired from Cape Canaveral.

A partial list of other programs would include the *Sergeant*, Lockheed X-17 *Polaris*, Re-entry X-36, *Jupiter Jr.*, *Jupiter Sr.*, *Polaris* O, *Polaris* A, *Polaris* A1X, *Polaris* A-2MOD 1-2-3, *Nike Hercules*, *Zeus*, *Minuteman*, *Pershing*, *Scout*, and others.

In several of these programs, Excelco has turned out cases in record time without some of the sophisticated frills called for in the specs. The units performed successfully and kept many schedules from slipping. In one instance, Brooks and his methods chopped a year from a crucial program.

There are many problems other than hardware that have to be solved—new fuels, erratic burning, lining, insulators, nozzles, etc. It is not necessary to spend large sums on tooling for high grade designs. All that is needed at this stage of the game is a good pressure vessel. ■

FAR LEFT: *Cylindrical sections are welded in a fixture easily expanded to accommodate 160-in.-diam. models.*

LEFT: *Mating sections of the segments are machined to exacting tolerances by modifying standard equipment and imaginative fixturing.*

RIGHT: *The big booster illustrates 1961 state of the art; the long white case represents the largest chamber made in 1958.*

Costs Bolster Case for Solid Booster

Lockheed's Thackwell asserts that solids, despite weight, can do space jobs far more cheaply than liquids

THE BATTLE between proponents of liquid and solid propellants for use in space boosters got an unexpected airing last week when a partisan for solids addressed the Third Meeting of the Joint Army-Navy-Air Force-NASA-ARPA Liquid Propellant Group, which convened November 7-9 in Miami.

Following on the heels of the Golovin Committee's reported backing of large solid boosters (120 in. dia. and bigger), the speech also furnished some of the reasoning behind the Committee's decisions—based in part on NASA-sponsored studies made at Lockheed Propulsion Co. (formerly Grand Central Rocket Co.), where the speaker is executive vice president.

The Lockheed executive, H. L. Thackwell, Jr., affirmed that solid boosters can perform space missions far cheaper than liquid. Moreover, he recommended that solid rockets be developed as back-ups for the giant-size, liquid upper stages the government is considering using for space missions of international significance.

Chief reason given for using such solid upper-stages is that no liquid hydrogen-oxygen engine of any size has yet been flight tested by the U.S.

• **Solid Saturn booster best**—For *Saturn*-size launch vehicles using LOX-Hydrogen propellant upper stages, Thackwell stated:

—The R&D program for a solid booster could be done for less than one-sixth the cost of an equivalent liquid booster using LOX-RP propellant.

—Launching costs would be about the same for each of the vehicles because the solid-boosted vehicle would use the same liquid upper-stages as the comparable liquid-boosted vehicle.

—Manufacture and delivery costs of the solid booster would be less than one-third that of the equivalent LOX-RP liquid booster.

—The overall cost of putting a pound of payload into orbit for 100 routine flights would be cut by more than one-half by using a solid-propellant booster; or, the solid booster would allow twice as much payload to be put into orbit for the same space budget.

For this analysis, Thackwell said his company used actual NASA cost data for liquid-booster development, manufacture, and flight test; and Lockheed Propulsion data for costs of large solid-propellant boosters.

The chief differences between solid and liquid propulsion systems—with respect to cost and performance—are that the hardware part of the solid booster is cheaper than that of the liquid; but that the liquid booster uses less expensive propellant and also has a higher specific impulse.

As a result, the solid booster must be considerably heavier than a liquid booster having the same mission of accelerating a given upper stage and payload weight to the desired boost velocity.

Noting these facts, Thackwell referred to a recent statement by Wernher von Braun, director of NASA's Marshall Space Flight Center: "We must optimize our launch vehicles in terms of minimum overall cost consistent with the time allotted for mission accomplishment, rather than use the meaningless approach of optimizing for minimum gross weight."

In other words, launch vehicles should not be optimized for minimum gross weight but rather for the minimum overall cost to do the required job. Thackwell pointed out that these two criteria are not equivalent to one another:

"For given performance requirements, large solid boosters can be shown to be less costly than large liquid boosters, primarily because the liquid-rocket, non-propellant hardware is . . . so very expensive. . . . The solid boosters will weigh more but they will cost less, both in development and production."

He added that for the much smaller upper stages, which need to be relatively lightweight so as not to "weigh down" the booster stages, the overall cost balance is decidedly in favor of using the much higher specific-impulse LOX-Hydrogen engines, despite their great cost per pound.

• **Liquid hardware costs high**—When a large number of identical space flights are involved—50 or more—the largest cost

TABLE 1—Liquid- versus solid-booster costs for 8000 fps boost velocity.

	LOX/HYDROGEN BOOSTER STAGE	SOLID BOOSTER STAGE
PROPELLANT COST/lb	$0.20	$1.00
HARDWARE COST/lb	$150.00	$12.00
PROPELLANT FRACTION	0.94	0.88
HARDWARE FRACTION	0.06	0.12
TOTAL COST/lb	0.20(.94)+150(.06)=$9.19	1.0(.88)+12(.12)=$2.32
BOOSTER WEIGHT RATIO	1.0	2.94 (t_b=150) 2.07 (t_b= 75)
BOOSTER COST RATIO	1.0	2.32(2.94)/9.47=0.72 (t_b=150) 2.32(2.07)/9.47=0.506 (t_b= 75)

factor in the launch-vehicle program are the booster manufacturing costs, according to Thackwell. Table 1 shows a simplified comparison of these costs for boosters required for large space-launch vehicles.

Thackwell described the table as showing costs for booster stages made up of clusters of liquid- or solid-rocket engines and include the clustering and interstage structure, and the thrust-vector control systems. Although no costs were included for fueling the liquid booster, the cost of propellant for the solid booster includes propellant loading.

The liquid costs are said to be estimated from NASA data and the solid costs from Lockheed Propulsion Co. data. Both cost estimates are for the tenth delivered booster stage.

Here are Thackwell's conclusions:

—LOX-Hydrogen boosters cost four times as much per pound as solid boosters. Therefore, since solid boosters will weigh only two to three times as much as liquid boosters—depending on burning times chosen—the solids will cost only 50% to 70% as much as the liquids.

—In another view, LOX-Hydrogen boosters will cost from 1.4 to twice as much as solid boosters to perform the same high-performance mission. And for boost velocities of less than 8000 fps, the solid boosters will be even more economical. (If a boost velocity of only 5500 fps is required, the LOX-Hydrogen booster will cost nearly 2.7 times as much as the 75-second-burning-time solid booster.)

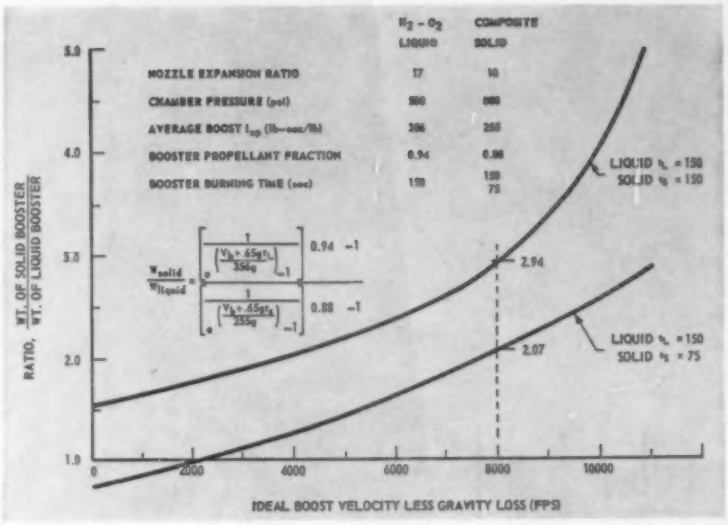
"Forcing the use of liquid propellant systems in the early boost phase represents a 'round hole, square peg' combination which could cost the taxpayers billions of dollars over the coming decade," Thackwell said.

Thackwell admitted that for very large space launchers—such as *Saturn* and *Nova*—the solid vehicle is not clearly the best choice, chiefly because of its lower specific impulse.

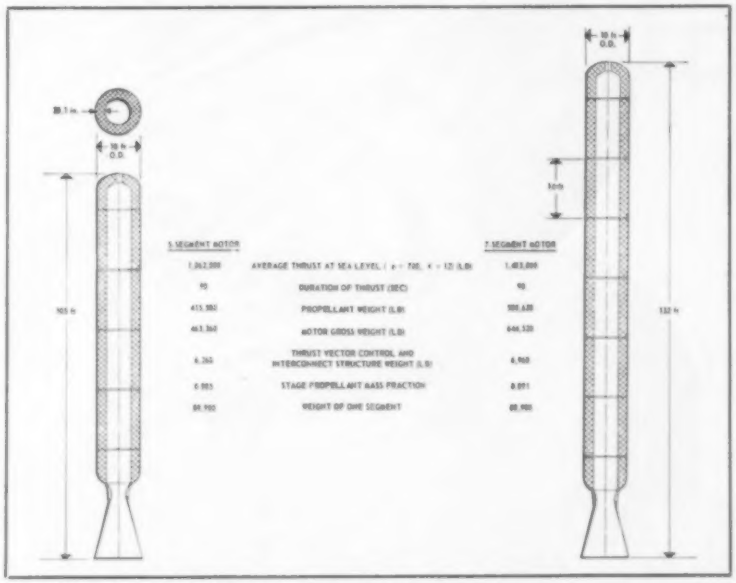
Nevertheless, he warned that "It is entirely possible that excessive delays in the present liquid upper-stage development programs may result because of altitude ignition, sloshing, zero gravity, structure freezing, cluster rigidity or other problems."

Calling for upper-stage back-ups consolidated with solid boosters, he recommended that a family of simple, all-solid-propellant space launchers be assembled from segmented, solid-propellant-motor building blocks.

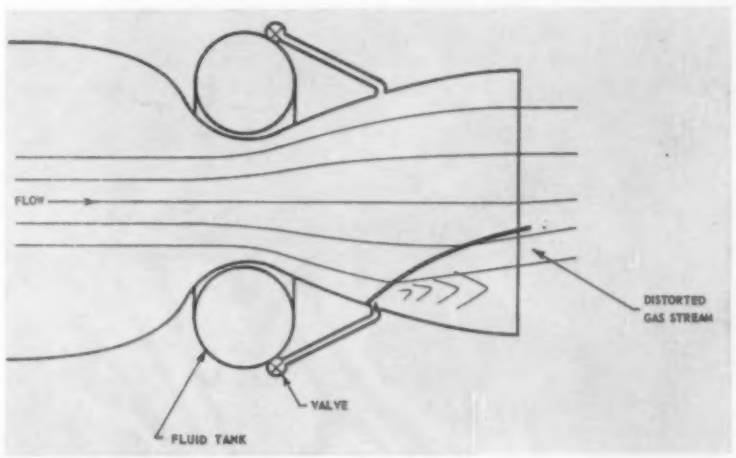
Thackwell maintained that by using 13.5-ft. diameter motor segments, a simple 3-stage, all-solid-propellant launch vehicle able to place 89,000 pounds into orbit could be operational by 1964. ■



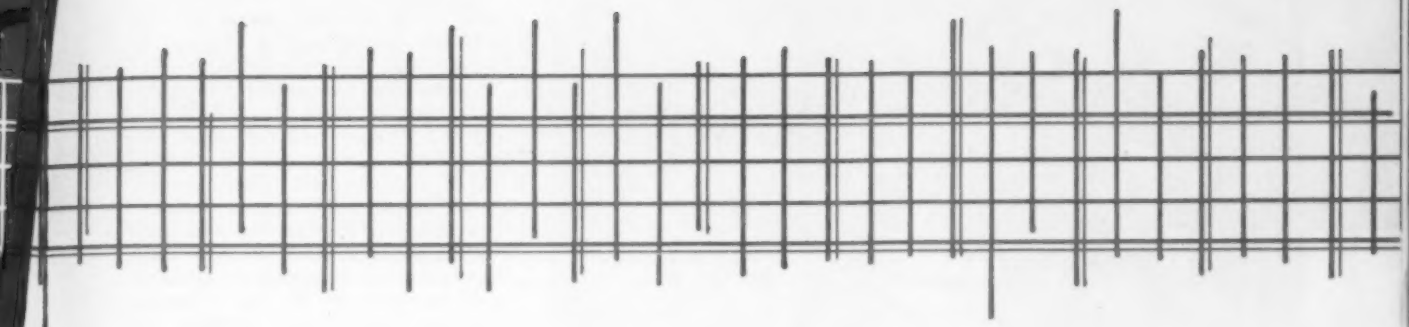
RATIO OF SOLID-BOOSTER to liquid-booster weight vs. actual boost velocity.


5 SEGMENT MOTOR
7 SEGMENT MOTOR
AVERAGE THRUST AT SEA LEVEL
DURATION OF THRUST (SEC)
PROPELLANT WEIGHT (LB)
MOTOR GROSS WEIGHT (LB)
THRUST VECTOR CONTROL AND INTERCONNECT STRUCTURE WEIGHT (LB)
STAGE PROPELLANT MASS FRACTION
WEIGHT OF ONE SEGMENT

LOCKHEED PROPULSION'S proposed 10-ft.-diameter solid propellant motors.



SECONDARY fluid injection thrust vector control.



genus: homo · species: sapiens discipline: factors engineering

At the six major RCA Defense Electronic Products facilities, teams of psychologists and design engineers are deeply involved in the highly specialized, incredibly complex study of human factors engineering—man/machine interfaces, auto-instructional methods, decision processes, read-in/read-out optimization techniques, sensory perception, the entire spectrum of psychological-physiological-physical disciplines.

Whether your requirements involve human factors study of command and control functions for defense networks, or projected life support systems for space exploration, a total RCA capability stands ready to assist you . . . from feasibility study to project completion. Write Defense Electronic Products, Radio Corporation of America, Camden, N. J.

RCA®

The Most Trusted Name in Electronics

RADIO CORPORATION OF AMERICA

Circle No. 4 on Subscriber Service Card

*Pyro-Eye measuring temperature in a vacuum furnace. Photo courtesy of Richard D. Brew and Company, Inc., Concord, N. H.

When high temperatures are critical,
rely on PYRO-EYE®
for accurate precise control*

Pyro-Eye, an automatic two-color optical pyrometer, measures the temperature of an incandescent object as a function of energy radiated at two wavelength bands. By using this *ratio* principle, the instrument is not appreciably affected by film deposits on a sight glass nor smoke, haze or condensable vapors in the atmosphere. That's one reason why Pyro-Eye is ideally suited to high temperature control in heavy industrial application. It is equally at home in the research or control laboratory.

PYRO-EYE delivers a recorder output voltage allowing direct connection with conventional recorders or recorder-controllers.

PYRO-EYE accurately measures temperatures over a very wide range. Standard models measure from 750°C to 3500°C (1400°F to 6300°F).

PYRO-EYE is ruggedly built; service requirements are minimal.

For full information, write for Bulletin 613, describing Pyro-Eye in detail.

IDL®

INSTRUMENT DEVELOPMENT LABORATORIES, INC.
Subsidiary of Kollmorgen Corporation
61 MECHANIC STREET, ATTLEBORO, MASS.

New Plasma Lab

Ionospheric Research Gets Air Force Push

THE AIR FORCE will expand its activities in the field of plasma physics research with the construction of a $636,000 laboratory at L. G. Hanscom Field in Bedford, Mass.

The new Gaseous Physics Research Building will be part of the Air Force Cambridge Research Labs and will house facilities for ionized plasma production, diagnosis, and interaction experiments.

The Farina Corp. of Newton, Mass., has been awarded the construction contract and the building is expected to be completed in October, 1962.

Included in the plant will be equipment for fabrication of gas-filled system and tubes, plasma containers, and experimental devices used in production of ionized plasma. This equipment includes hydrogen-fired and vacuum-type furnaces, electroplating and electrocleaning installations, vacuum evaporators, induction heaters, and standard glass manipulation facilities. Optical and mass spectroscopic facilities will also be available for use in component identification and purity determinations.

• **High power** — The breakdown phase of plasma production may be accomplished by either electrical or physical means. On hand at the research site will be generators capable of peak power outputs, in excess of 10 megawatts at 3000 mc.

Other generators will be available in the UHF range to frequencies of 140,000 mc. These units represent a considerable increase in electrical breakdown power over presently available systems. The power plant for the planned plasma jet lab will be capable of producing high-temperature ionized gas streams generated by 10 kw input power. Solar and arc imaging facilities will be installed for physical breakdown processes.

Facilities will be provided to simulate the required conditions for various diagnostic techniques. These techniques range from plasma probes with weak microwave signals to physical probes involving actual material insertion of particle beams.

The study of actual plasma interactions which will be carried on at the research facility will cover several areas, with considerable effort devoted to ionospheric simulation work. An extreme-environment lab is being installed for this purpose.

High- and low-power microwave labs, and a high-density lab will be equipped to study problems such as communication black-out due to plasma sheaths or nuclear detonations. ⌗

Circle No. 12 on Subscriber Service Card

BELL SCIENTIST R. E. Flexman flies through interior of Air Force C-131 during period of weightlessness propelled by experimental model of Zero Gravity Belt.

HORIZONTAL movements with belt are checked out on Bell's air-bearing platform.

propulsion engineering

Bell's One-man Belt for Astronauts

A ONE-MAN propulsion system for stabilizing and positioning a free-floating man in an orbital environment is in advanced development by Textron's Bell Aerosystems Co.

A cold-gas engineering prototype unit recently completed 81 flight tests in an Air Force C-131 aircraft flying Keplerian trojectoreis at high speed to achieve short periods of weightlessness.

Bell scientists say the experimental Zero Gravity Belt has been a successful research tool for evaluating the concept of a self-maneuvering unit and specifying the performance characteristics of improved, operational systems.

The prototype used super-dried high-pressure nitrogen as a propellent because of test environment constraints. The operational model will employ hydrogen peroxide or some other bipropellent more suitable to a space mission.

• **Space corset**—The device consists of high-pressure tube bundles attached to a snugly fitting fiber corset and worn on the middle of the torso. Two thrust controller units are placed on the belt at the body's center of gravity level, one on each side.

Each unit contains a manifold block having eight gas orifices with integral shutoff valves. The orifices, or thrust valves, are controlled by the operator to propel himself in any direction or axis of rotation. The operator pushes, pulls, lifts, depresses, or rotates the hand controllers in the desired direction. For example, pushing down on the controllers opens the two top thrusters on each manifold block, forcing the man downward.

A total of 32 (1.25 x 0.035 in.) tubes are used. Two tube bundles of 16 each were made in lefts and rights and curved to fit the torso. Two rows of eight each make up a bundle. The tubes in each bundle are manifolded together at the back and hinged for donning ease.

High-pressure flexible tubing connects the manifolds. Nitrogen at 3000 psig is stored in 26 tubes while 6 tubes hold low-pressure gas. The high pressure is reduced through a regulator that keeps the low-pressure tubes at 320 psig.

• **Pressure step-down** — The low-pressure tubes feed directly into the controller manifolds. Chamber pressures of 185 psig provide about 8 lbs. vacuum thrust from each of the two nozzles for fore-aft and lateral translation and 4 lbs. from each of the four nozzles for vertical translation.

The thrust system was designed to produce a maximum of 20 lbs. thrust by using paired thrusters for all translations and rotations.

The controls in the prototype are self-centering and require a 6-lb. actuation force. Control motion is approximately 0.25 in., fully opening or closing the valves.

Maximum thrust at sea-level pressures has been measured at 16.35 lbs. This level can be continuously maintained for only 11 seconds, but short bursts have proven adequate for maneuvering during the short weightlessness periods experienced in the C-131 aircraft.

The belt's ultimate purpose is to permit external, manned inspection, repair and assembly tasks on orbiting space vehicles. The advanced unit will have a simpler control system and might include variable thrust.

The operational propellent may be H_2O_2—the same system proven successful on Bell's Army Rocket Belt (M/R, June 12, p. 21) and in the reaction control system developed by the firm for the *Mercury* capsule (M/R, Oct. 9, p. 22). ■

Honeywell ESG Slated for Duty in P

Company describes first operational electrically suspended gyro as it opens $5-million missile/space R&D Plant

by Charles D. LaFond

MINNEAPOLIS—The first electrically suspended gyroscope (ESG) to see military operational use will be used to monitor the Navy's *Polaris* submarine SINS, Ship's Inertial Navigation System.

The result of five years of research by Minneapolis-Honeywell Regulator Co., and a $15-million investment by the Navy and the Air Force, engineering models will be ready for delivery by next spring. First production models and deliveries to the Navy for installation in its *Polaris* submarine fleet will begin in mid-1963, a Honeywell spokesman said.

Only one moving part—a superbly machined beryllium rotor—is required by the new gyro. Supported within a vacuum solely by an electromagnetic field within an outer ceramic shell, the hollow sphere is expected to rotate almost indefinitely after initial run-up. Essentially frictionless, it will provide at least magnitude improvement in gyro drift rate compared to the best conventional floated gyro now available.

ESG details and other advanced developments were revealed here recently by Honeywell officials at a large press gathering prior to dedication and official opening of the company's new Aeronautical Division Research Center. The multimillion-dollar facility will be the heart of Honeywell's advanced R&D effort in inertial systems and flight control technology.

TWO-TON SPACE SIMULATOR is air-bearing-supported to isolate it from frictional and gravitational influences. Supporting concrete pad beneath is also isolated from building. Developers believe the system is 20 times more accurate than any similar instrument in existence.

In describing the ESG gyro, R. O. Maze, chief engineer and director of the project, said the baseball-size rotor is fabricated from hot-compacted beryllium. Infinite patience, he stressed, is required in machining and polishing the ball to a final accuracy of better than five millionths of an inch in sphericity.

A diamond scriber is employed later to fashion an intricate pattern on the rotor surface. The pattern permits use of optical pickoffs to sense rotor position when in operation. To minimize the introduction of error by the optical pickoffs, the sensors are accurate to ±2 sec. of arc, Maze said.

When the gyro is in operation, separation between rotor and outer shell measures 0.025 in.

In its first application with the SINS, Honeywell's ESG will be used to check and recalibrate each of the three inertial platforms on which the submarine is dependent for navigation. The complete monitor system will include a small special-purpose digital computer to help determine gyro corrective values. Outputs will go directly to the existing NAVDAC control computer used with the SINS, Honeywell said. (All of the other navigational aids used to correct SINS also are routed to the NAVDAC. These include automatic star tracking, Loran-C, and other radio-direction finding inputs.)

Polaris Subs

NEW AERONAUTICAL Div. Research Center recently dedicated in Minneapolis represents $5-million investment by Honeywell. Highlighted in glass front (foreground) is massive analog-digital computer complex capable of simultaneous solution of both scientific and business problems.

Concurrent with development of the SINS monitor, an advanced ESG also is being built for missile/space application. Considerably smaller than the earlier version, the new gyro will employ a rotor about the size of a golf ball.

The complete gyro will be housed in a cylindrical container measuring 4.75 x 3.5 in. dia. Weighing roughly 4 lbs., the miniaturized package will require less than 4 watts power for operation.

For the future, Honeywell believes the new gyro offers another significant feature: It may be possible, because of the type of suspension, to sense acceleration. If the unit can be instrumented properly to utilize this potential feature, a complete inertial platform could be built using only three gyros and no accelerometers.

• **New research center**—Destined primarily for research and development of advanced missile/space guidance and control systems, Honeywell's new Aero Division facility will provide its 5000 scientific occupants and administrative personnel with every means to reach this end.

An outlay of $5 million has purchased a plant of 65,000 square feet, equipment, and modernization of other facilities. Besides the typical laboratory facilities expected of such an installation, the new center will have what Honeywell feels are the most advanced clean room facilities and computer complex available in the United States today.

Capable of handling simultaneously both digital and analog computation plus business-type computer problems, the new data processing center has been developed around the M-H 800 computer. This and 16 integrated analog computers will be operated by a staff of some 117 persons, the company said. Assembled over the past several years, the system cost over $3 million.

The Company officials indicated that the huge facility will provide computer services to not only the Minneapolis portion of the Aero Division but its St. Petersburg, Fla., and Los Angeles installations.

The clean rooms which will be used for the final assembly of ultra-precision gyroscopes and accelerometers have been refined in design, according to the builders, to a point never before obtained in industry.

Contamination by airborne particles has been reduced significantly. Temperatures and humidity are rigidly controlled, while dust is removed by series-connected mat filter, electrostatic filter and two absolute filters. The complete volume of air in the rooms, Honeywell said, is changed up to 20 times/hr.

Over $750,000 was spent to perfect the new rooms with the result that airborne contamination of particles over 0.3 micron will be reduced to no more than 5000/cu. ft.

Also, the center includes a superbly balanced spacecraft simulator that will be used to test delicate guidance systems.

Weighing almost 4000 lbs., the simulator has a circular specimen platform measuring 6 ft. in diameter. Its center column is air-bearing-supported. The system is believed 20 times more accurate than any other similar system now in existence.

Heart of the bearing suspension is A 10-in. stainless steel ball machined to an accuracy of 10^{-5} in. in sphericity.

Free to revolve 360°, the instrument has a 30° freedom in the roll and pitch axes.

• **New control for X-15**—Also revealed for the first time by Honeywell officials was the fact that the vaunted M-H adaptive flight control system is being installed in one of NASA's *X-15* hypersonic test vehicles.

First flight test using the new system is scheduled for late November or early December, according to C. L. Davis, vice president and general manager of the Aero Division. Prototypes, he said, already have undergone thousands of hours ground testing and over 300 hours of flight testing in an F-94 and an F-101, both supersonic fighter aircraft.

The systems will be used to obtain automatically the best reaction-fuel efficiency and flight control conditions at all operating attitudes and speeds.

Both aerodynamic and reaction jet control are possible with the system, Honeywell said. The same system with but slight modification will be used in the AF *Dyna-Soar I* boost-glide space vehicle, now being developed by The Boeing Company.

A 92-lb. computer is the central control unit for the system. Employing dual redundancy in its circuitry, the subsystem has a designed reliability estimated at 200,000 hours mean time between failure.

The adaptive flight control system has been in R&D for the past 6 years and in flight test over a period of 12 months, said Honeywell.

The new system is being introduced to the *X-15* now to permit the vehicle to attain higher altitudes in its upcoming test flights. Transitions from aerodynamic to reaction controls will take place at about 130,000 ft. For a short period during both atmospheric exit and re-entry both control systems will be energized. ⌗

Pre-D to Enhance AMR Data Gathering

Dynatronics system soon to be installed at Canaveral increases reliability, reduces complexity and volume of equipment

ATLANTIC MISSILE RANGE data collection facilities are expected to be greatly improved by an advanced pre-detection/recording system now under development.

The first system, designed and developed by Dynatronics, Inc., of Orlando, Florida, is scheduled for installation at the Air Force Missile Test Center at Cape Canaveral late this year.

Present Air Force plans reportedly include use of additional pre-D systems at down-range stations and on MARS (Mobile Atlantic Range Station) ships.

Also, it is believed that both the Pacific Missile Range and the National Aeronautics and Space Administration are considering use of the system at selected ground stations.

Primary advantage of the pre-D technique, developers say, is that of standardization and minimal equipment outlay for remote stations. One four-rack system will allow such stations to receive and record any type of analog or digital telemetered data, including PCM, FM, PAM, or PDM. It will also handle any data transmissions of the future. This feature, says the Air Force, is especially important in today's transitional period of an increasing use of PCM (digital) telemetry along with extensive use of existing analog equipment and the prospect of combination systems (such as PACM) in the near future.

Basically, the system works like this:

Incoming telemetered signals are picked up in the receiver at the intermediate-frequency stage (before detection) and recorded in the form of an i-f carrier. The modulation sidebands recorded are identical with those of the signal originally received, regardless of the type of modulation used.

Later, this recorded i-f carrier is played back through the detector and demodulator and recorded (and/or displayed) to recover the original video data for processing.

In actual application, the playback and demodulation processes will be carried out at a central station where different types of detection equipment to fit the specific modulation methods are available. Only one set of the various demodulation systems is thus required to service all the down-range and other remote collection stations.

In addition to this primary advantage, Dynatronics engineers assert there are other advantages in the use of pre-D.

• **Operational advantages**—Operationally, predetection increases the reliability of data acquisition and improves the operational procedures for telemetering systems.

To the user, the value of predetection data collection depends to a great extent upon the number of different types of telemetry signals necessary to record.

For a single missile project—or for a family of vehicles which use the same type of telemetry equipment—building space and operator skill requirements are practically the same whether post-detection or predetection recording is employed. Futhermore, such programs are normally planned and budgeted well in advance for their telemetry requirements so that the necessary facilities are available for operation when required.

By contrast, at the national ranges and other R&D facilities this is not always the case. Many different signal types must be handled each day. Also, frequently, new types of data and foreign signals must be collected upon short notice, with little or no lead time for the procurement of requisite equipment. Budget limitations are always a consideration and the advance training of operating personnel to cope with new types of data modulations is a continuing problem.

Predetection data collection will significantly improve this situation. A single pre-D system in a standard operation can collect any type of data which can be transmitted by a radio within a bandwidth of 2 mc or less and simultaneously record several channels of data. Also, it can be shifted quickly to different channels in rapid succession, regardless of the type modulation used on each.

Another advantage, developers see, operationally and technically, is the "freedom from frustration" which pre-D brings to the telemetry operator.

Traditionally, operating personnel stand at the equipment during a mission with one eye on the tape machine, one eye on the tuning meter, and one hand on the vernier tuning control. To avoid or minimize distortion they must continually "peak the tuning" to keep the signal centered in the discriminator. As the number of r-f links per bird increases, this procedure becomes more and more difficult.

With pre-D, signals are recorded before the discriminator, and system bandwidths and linearity are ample to tolerate frequency drifts without degradation of the predetected recorded data. Once the data are recorded on tape, repeated playbacks are possible, each tuned up for optimum reproduction of some portion of the transmission.

• **Technical advantages**—The linear operation of predetection recording is greatly superior to the non-linear technique of detection prior to recording, particularly when a desired weak signal is imbedded in strong noise and interference. Any non-linear operation mixes or cross-modulates the signals and noise.

For noise levels comparable to that of the signal, a threshold is rapidly reached, below which a signal is irretrievably lost in the noise. Modest improvements are possible by narrowing the i-f filter bandwidth so that less noise power reaches the detector. However, the filter bandwidth cannot be made smaller than the modulation spectrum bandwith without reducing the signal power and distorting the detected video. Furthermore, even slight instability of transmitter-receiver frequency would

WANT MORE INFORMATION?

USE THIS HANDY FREE READER SERVICE CARD TO GET MORE DETAILED INFORMATION ON ADVERTISEMENTS, NEW PRODUCTS, TRADE LITERATURE FEATURED IN THIS ISSUE.

We can't process the card unless company affiliation and title are given. Use home address for employment ads and please limit your requests to ten items.

NAME

TITLE/POSITION

COMPANY

Product Mfg./Service Offered

BUSINESS ADDRESS

CITY ZONE STATE

MISSILES AND ROCKETS

NOVEMBER 13

Expires Three Weeks After Above Date

CIRCLE NUMBERS BELOW FOR INFORMATION ON PRODUCTS, LITERATURE OR ADVERTISEMENTS

• • Advertisements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125

• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

• • New Missile Products

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

• • Other Information

GET ALL THE DETAILS . . .

ABOUT ADVERTISEMENTS AND NEW PRODUCTS IN THIS ISSUE.

1. **Circle the appropriate reader service numbers on the reverse side of the card below.**
2. **Fill out the card completely . . . company affiliation and title are a MUST.**
3. **Tear out the card and drop it in the mail box—we pay the postage and we contact the manufacturer for you.**

No Postage Stamp Necessary If Mailed in the United States

Postage Will be Paid by Addressee

BUSINESS REPLY MAIL

First Class Permit No. 47, Ridgefield, Connecticut

MISSILES and ROCKETS

P. O. BOX 621

RIDGEFIELD, CONNECTICUT

SUBSCRIBER SERVICE DEPT.

shift signals outside a narrow i-f passband and seriously degrade data recovery.

Since the predetection recording is linear throughout, it does not marry signals and noise and thus does not suffer when ample i-f bandwidths are employed. I-f selectivity is required primarily to reject interference from strong signals on nearby channels, to avoid overloading the system. Once the signals are on tape they may be played back many times with different combinations of bandwidth, detectors and other adjustments, to get the best possible signal from each section of the mission.

For example, in the boost phase, (while signals are strong), wide-bandwidth playback filters are used. Later, as the signal drops, the tape is stopped and narrowed-band filters switched in. Following a signal dropout, the tape can be played back in reverse so that phase lock, and/or sync, regained during subsequent strong signal reception can be "run back" down the other side of the canyon.

It will also be possible with minor equipment modification to make individual frequency drift corrections during playback, holding the i-f accurately within a narrow passband and precisely centered on the discriminator. Hopefully, other technical advantages of the pre-D technique will be discovered as predetection becomes more common.

• **Theoretical advantages**—A major theoretical advantage of predetection recording is the capability of employing sophisticated correlation detection techniques to recover weak signals that are completely indistinguishable by conventional techniques.

Basically, correlation detection involves the multiplication and averaging of the incoming signal, plus noise, with a locally generated "estimate" of the signal, or of its several possible forms.

In one method, numerous successive trials are made, in each of which the time relationship between the recorded predetection input and local reference signals is successively changed. Correlation—or time synchronism—is indicated by a definite peaking of the integrated product at a certain value of the time shift. Use of this technique in the past permitted radar contact with Venus to be established successfully by M.I.T. from Millstone Hill and contact with the sun from Stanford University.

Another form of correlation detection multiplies the input with each of the several forms in which the unknown signal can be coded. By proper design of the coding function an affirmative "present" output will be obtained from only the detector whose local input code is identical with that of the transmitted signal.

Application of the present AMR predetection data collection system to correlation operations is somewhat limited by the recording medium. In synchronous detection operations, where the timing precision of reproduced signals depends upon physical stability of the tape and mechanical accuracy of the equipment, correlation is practical only over millisecond intervals. More elegant techniques use a precision reference frequency recorded on the tape simultaneously with the signal to minimize physical and mechanical perturbations.

A more fundamental improvement accrues from direct digital processing of the recorded predetected i-f. Elaborate digital sampling and processing techniques were employed in both the Venus and sun radar experiments. Theoretical improvements in signal-to-noise ratio of 40 db or greater are predicted through the employment of correlation detection, made possible through predetection recording.

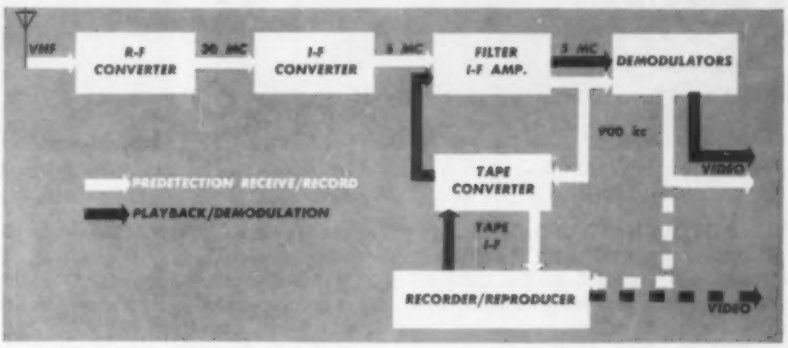
• **Recorder problems solved** — A major problem in the development of the pre-D system was the requirement for a magnetic tape recorder with characteristics advanced beyond that of available equipment. These needed characteristics included such items as a substantial reduction of intermodulation distortion, frequency response to above 1.5 mc at 120 ips tape speed, and almost complete elimination of dynamic and static tape skew.

The recorder also had to be able to record simultaneously the received signals in both predetected and detected forms.

Such a system was developed for the pre-D system by Consolidated Electrodynamics Corp., according to Dynatronics. It records seven independent data tracks on half-inch magnetic tape at six different tape speeds ranging from 3⅞ to 120 ips.

A unique feature of the recorder is an automatic dual-machine transfer which permits the collection of data for long periods of time without interruption. As the end of the tape approaches on one machine, a sensor starts a second machine. Data are recorded on both tapes during a 30-sec. overlap period, then the first machine stops and the second continues to record. These novel end-of-tape sensors operate with no marking or other special preparation of the tape to initiate the transfer operation.

In a recent demonstration of the recorder's overall performance, CEC engineers recorded all the r-f signals in the broadcast band (roughly, 1 mc) on a single track of the half-inch tape. On playback, any of the dozens of radio stations broadcasting in the Los Angeles area could be tuned in on a receiver connected to the recorder output.



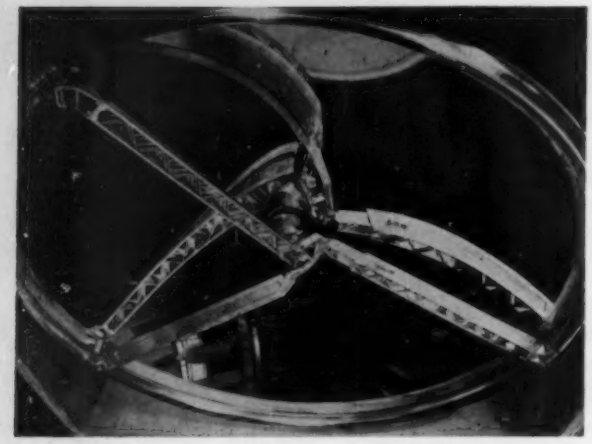
RECEIVED VHF SIGNALS are converted to 30 mc, to 5 mc, and then to 900 kc or 450 or 225 kc, according to tape speed i-f for predetection recording. On playback, the reproduced i-f is shifted back up to 5 mc for demodulation. The system can record simultaneously both pre- and post-detected data on the same tape.

• **"Twinband" technique** — A new method also has been devised by Dynatronics to record certain telemetered signals requiring bandwidth in excess of 1200 kc available in the basic system.

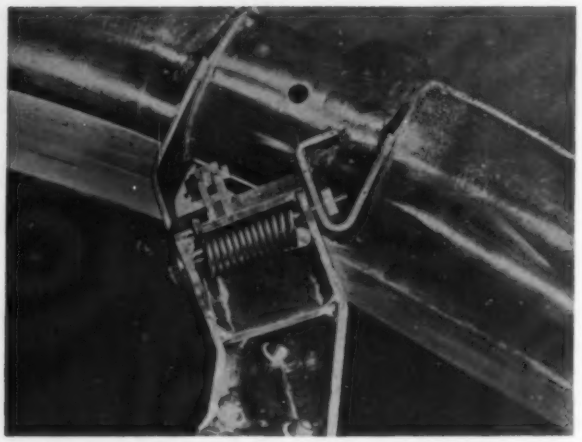
Called "twinband," the technique effectively doubles the bandwidth capability of the system by carefully splitting the wideband input signal, recording the two portions on separate tape tracks, and precisely recombining the signals on playback. Special circuits maintain symmetry and phase-coherence, so that the entire splitting, recording, and splicing operation produces only minor perturbations in the played-back signal.

The company estimates that an effective bandwidth of 2000 kc can be achieved using twinband with detected data distortion of less that 2%. Bandwidths of up to 2400 kc can be handled with the system, developers say, but distortion levels at that spread have not yet been determined. ■

EOS Perfecting Metal Space Mirrors



PROTOTYPE MODEL Solar Energy Conversion System has light, 5-ft. concentrator with generator support struts.



SUPPORT BRACKET is integrally electroformed with mirror structure. Arm is thermionic generator support strut.

LIGHTWEIGHT metallic mirrors of astronomical quality for space power systems are expected to be achieved within a year at Electro-Optical Systems, Inc.

EOS experts say the factors affecting surface accuracy are well known and understood. Studies in progress are aimed at controlling these variables.

A second objective at the firm is to develop applications and utilization techniques more fully exploiting the unique properties of all-metal mirrors. Besides low weight, metal mirrors have thermal conduction characteristics which can be used to advantage in systems requiring great thermal shock resistance.

Such applications include infrared systems which require cooled optics, and even large earthbound optical systems which suffer from thermal stability problems with glass mirrors.

A long-range possibility is that of actively controlling the mirror figure by precision differential heating.

EOS uses the angular surface deviation in mirror quality comparisons. This is the average or mean angular deviation of surface from the true geometry. The three main ranges are defined in terms of angular error. Thus searchlight-quality mirrors are designated as having an angular error greater than ±2 minutes. Sub-astronomical-quality mirrors range between ±2 seconds and ±2 minutes. Astronomical quality means an angular error less than 2 seconds.

• **Moving closer**—Searchlight quality is generally adequate for most power system solar generators, but EOS has been able to fabricate mirrors up to 5 ft. in diameter—lying on the borderline between searchlight and sub-astronomical. In smaller diameters—4 to 8 inches—mirrors have reached angular tolerances in the sub-astronomical range (angular errors of 1 minute and smaller).

Determination of the angular deviations of large concentrator reflectors has included a modified Hartmann test, using either the sun or a star as the light source, and photographic evaluation of the image of a bright star or planet such as Venus.

Sub-astronomical values are obtained with standard Ronchi and Foucault tests.

Most of the mirrors formed to date with the EOS process have been parabolas of revolution. Other shapes such as spherical, hyperbolic and elliptical segments, both on- and off-axis, have been made. The aperture ratio, or f number, has ranged from f/8 to f/0.4. The process forms all of these with equal ease.

• **Black magic** — EOS forms the mirrors through certain proprietary electro-chemical means. The reflectors are entirely metallic and of one material, with no organic or inorganic bonding elements involved. For maximum strength-to-weight ratios, a toroidal support or a monocoque backing structure is used. The support is the same material as the reflecting surface, and both are formed in the process.

Mounting or support tabs may also be integrally formed upon the structure as desired during the fabrication process.

The specific weight of these reflectors depends on their size, mounting method and strength requirements. EOS has reflectors with specific weights as low as 0.4 lbs. per square foot.

The 5-ft.-diameter reflector has a value of only 0.8 lbs. per square foot but successfully withstands simulated *Atlas*-launch g factors. EOS experts say mirrors can be made for nearly any conceivable application with specific weights no greater than 1.5 and probably less than half this value.

Most of the reflectors to date have been overcoated with vacuum-deposited aluminum for maximum reflectivity. Specular reflectance as high as 95% in the visible has been achieved with this coating. Other coatings may be applied with equal ease, with or without protective layers of silicon monoxide. Interference filters are also possible.

EOS can make firm quotations against specifications for these metallic mirrors. They anticipate that for quantities greater than 10, the unit cost would be at least an order of magnitude less than comparable polished glass reflectors. ⁂

BIOS Launching

(Continued from page 15)

whether fertilization and cell division are affected by weightlessness. Dr. Richard S. Young of Ames designed this experiment.

• **Radiation experiments** — Several neurospora (mold spores) experiments designed by Dr. A. Gib of Florida State will attempt to detect genetic changes brought about by radiation.

Oak Ridge National Laboratory's Howard I. Adler contributed an experiment using bacteria commonly found in the human intestine to determine its sensitivity to radiation. Another Oak Ridge experimenter, Frederick J. de Serres, has planned tests with dry spores designed to show survival and mutation rate in radiation.

Human blood and white corpuscle cultures will be exposed to radiation and compared with normal blood in an investigation conducted by Michael A. Bender of Oak Ridge. The effect of radiation on nerve fibers will be illustrated by grasshopper neuroblasts in another Oak Ridge experiment.

Barley seed, a genetically stable material, will be studied for radiation effects by Dr. James A. Eugster of the Universities of Bern and Zurich, Switzerland. ⌗

Lockheed-Georgia Adds Nuclear Lab Facilities

THE LOCKHEED-Georgia Company has expanded its nuclear research plant facilities with the acquisition of the Georgia Nuclear Laboratories, near Dawsonville, through a lease arrangement with the Air Force.

Scientists and engineers at the laboratories' 10,000-acre reservation are currently engaged in studies of radiation effects at low temperatures on various metals. The cyrogenic (low-temperature) project, which is being conducted for NASA, has been programed through 1964.

A study is also being carried on by Dr. Robert Platt, of Emory University in Atlanta, concerning radiation effects on plant and animal life in the vicinity of the Dawsonville reactor. Dr. Platt and other leading botanists and biologists from the university are engaged in the long-term ecological study under the terms of an AEC grant.

Current projects within Lockheed-Georgia's nuclear organization include investigations relating to nuclear-powered rocket systems and irradiation shielding for various ground-based and airborne military vehicles. ⌗

soviet affairs

By Dr. ALBERT PARRY

An antimissile missile

was mentioned in Moscow dispatches of October 23 and 24 to New York newspapers as an important boast by Marshal Rodion Ya. Malinovsky in the course of his speech delivered on the evening of October 23 in Moscow, at the 22nd Congress of the USSR's Communist Party. One dispatch by an American correspondent quoted from a Tass summary of the Marshal's speech a statement "that the Soviet Union has solved the problem of antimissile defense." The correspondent continued: "Although the Soviet Defense Minister did not specify whether a weapon had been developed, it was assumed here that he was speaking of an antimissile missile." Another American correspondent cabled that the Tass account included the Marshal's assertion that "the problem of destroying rockets in flight has been successfully solved" by Soviet scientists. Naturally enough, the news made front-page headlines in the American press.

But did Malinovsky make such claims?

The full Tass text of his October 23 speech, as it appeared in Soviet dailies for October 25, particularly in the authoritative military organ *Krasnaya Zvezda,* has just reached my office. I have examined it closely several times, but do not find any such references outright or implied, to an alleged Soviet antimissile missile, as claimed by Moscow correspondents of the U.S. press. There are indeed a few references to "antirocket defense of the country," but no declarations whatever that its problem has been solved by anything like an antimissile missile.

Among his remarks on Soviet missiles

the following are of interest: Soviet medium-range rockets (the Marshal revealed), when tried out during this year's field-games of Red rocket troops, hit their targets in 90% of their launchings. At the same time, Russia's ICBM's (according to Malinovsky) showed in their tests a yet better performance. "It may seem strange," the Marshal quipped, "but our rockets hit targets over long distances more precisely than when fired over short distances." At this thinly veiled threat in the American direction, the Communist delegates not only applauded, but also—to quote the Tass report of the session—displayed "a lively merriment."

Electronic computers were used

in the field during the 1961 maneuvers of the USSR's rocket and other troops, the Marshal said. Missile units proved that they could stop during their marches abruptly and wheel into action at once. The total of rocket units in the Soviet armed forces was placed by the speaker at about "1800 excellent detachments." These units are manned by "great masters of their business who can hit any point of the globe without missing."

Rocket weapons are so ample

in the USSR's arsenal (the Marshal went on) that "we are more than sufficiently supplied with missiles of various types and purposes." In the Soviet air force, missiles have replaced guns and machine-guns. "Rocket-bearing planes," Malinovsky announced, "are being introduced more and more widely." These, he added, are able to shoot their rockets from long distances, without going into the enemy's zones of antiaircrat fire. The Soviets' own antiaircraft guns are being rapidly displaced by antiaircraft rockets. The Marshal cited the following figures as illustrating Russia's rocketry advantage in antiaircraft defense: "During the last war, to destroy one enemy plane, antiaircraft guns had to expend an average of 400 to 600 shells. But the modern plane, possessing a great speed and reaching an altitude twice the height that antiaircraft shells can reach, may be shot by one rocket, or, at the most, by two rockets only."

Japan Testing Large Solid Rockets

New series of bigger sounding rockets forces move to less confining launch site on Pacific coast, due to be complete next year; solid technology reported advancing rapidly

by Bernard Poirier

NEW LAMBDA SERIES solid booster has Polaris-like nozzle configuration.

JAPANESE sounding rockets have outgrown their existing firing range on the Sea of Japan opposite the Soviet-Chinese coastline.

A new test center is being built on the Pacific for the new *Lambda* rockets.

As a follow-on in the Greek letter series, *Lambda* will considerably outperform its best predecessor—*Kappa 9L* which reached a maximum altitude of 236 miles at a launch angle of 82° and later slammed into the Japan Sea at a maximum range of 391 miles when launched at 78°.

Notable in Japan's space effort has been solid propellant progress. Graphic projections show a linear progression in grains from about 9 in. OD in late 1958 to 20 in. OD in early 1961. Recently, *Lambda 1*'s 28-in. OD booster grain was tested on a static stand on Akita Beach.

The booster motor introduced Japan's first four-nozzled configuration instead of a single unit used in all preceding vehicles. *Lambda's* booster (when full-size) will produce 42 tons thrust for 18 secs. and will use a high tensile strength 100 kg/mm^2 steel plate casing.

The first static test was on an 8 ft. motor and a second—about 17 ft. long—will be static-tested during November or December.

Full length—25 ft.—rocket motor static tests are scheduled for completion during fiscal year 1962 and *Lambda 1* should be ready for flight tests at the new Pacific location—Kagoshima Space Station—where completion of construction is expected before the end of 1962.

• **To the beach**—The last vehicle in the *Kappa* series overtook the horizontal usefulness of the Akita Rocket Range. *Kappa 9L*, for example, could have reached the beaches near the Russian city of Olga if fired along the proper azimuth.

Speaking at the Third International Symposium on Rockets and Astronautics, Tokyo, Professor Hideo Itokawa, head of Japan's space efforts, said,

s in Expanding Space Program

"even by a 80° launching angle, the horizontal range (of *Kappa 9L*) exceeds the geographical dimensions of the Sea of Japan."

For new Japanese sounding rockets, "a new launching site was required and a geographic survey was performed along the Pacific Coast of Japan and finally for many reasons," he added, "Kagoshima Space Station was selected and is now under construction."

• **Kappa to Yugoslavs**—The Japanese reportedly have sold $227,000 worth of *Kappa 6* rockets and GSE to the Yugoslav Astronomical Association. *Kappa 6* is a two stage solid rocket capable of carryin a 22 lb. payload to 37 miles from an 80° launch angle.

Standard instrumentation included accelerometer, decelerometer, skin temperature gauge and strain gauge. Explosive grenades were used to observe temperature and upper atmosphere wind. A geiger counter was installed for cosmic ray counting and a Pirani gauge for pressure measurements. One successful recovery in the Japan Sea was reported for a solar spectograph package utilizing a float and parachute combination.

Automatic range and direction tracking radar (modified GMDI), four sets of range finders and a DOVAP system installation were used for tracking at Akita. Range and direction finders used a frequency of 1680 mc and DOVAP, 40-80 mc.

KAPPA 8, shown on its carrier, was last of series suitable for old range.

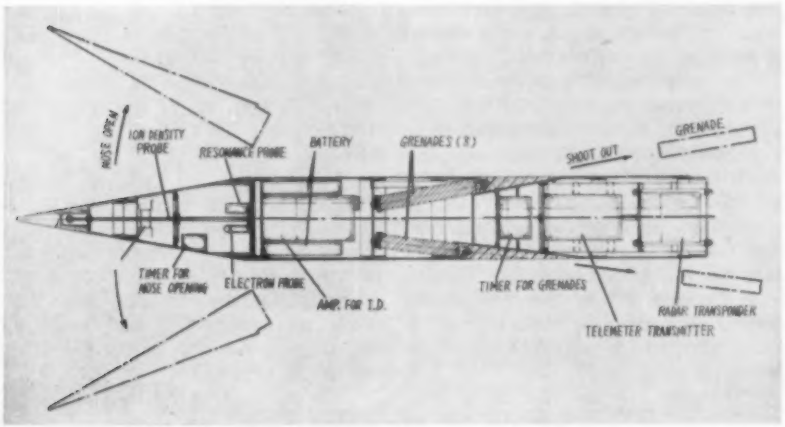
While relatively few construction details are available for the late *Kappa* series, it was revealed that *Booster 420B* for *Kappa 6* had high tensile steel fabrication with tensile strength over 85 kg/mm² using a welded butt joint. A 7 mm plate was rolled and welded to the cylindrical shell in this earlier effort.

A concurrent development in the last days of the *Kappa* series was the *Pie* sounding rocket with a glassfibre-reinforced plastic chamber combined with a slow-burning propellant.

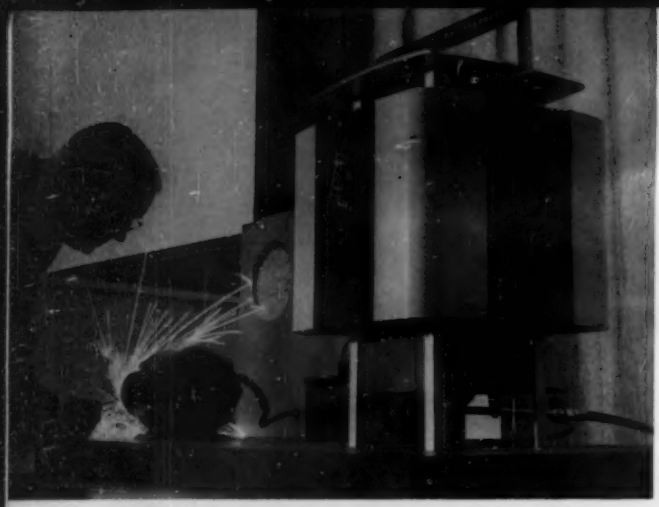
The three-stage *Kappa 9* was Japan's first experience with burning time outside the earth's atmosphere plus the accompanying problem presented by possible aerodynamic heating of the last stage propellant during the flight phases of the two boosters. Other problems involved stage separation and aeroelasticity factors of longer and slender vehicles.

A budget of less than $1 million was sufficient to bring the University of Japan's sounding rocket program through the *Kappa 6* plus a record of 60 various flight tests by late 1958. Many of these earlier rockets used ceramic coating, aluminum alloys and magnesium coating on the frame, and graphite in the nozzle throat.

The *Lambda* series with multi-nozzled boosters have a mission of placing more than 100 working lbs. over 350 miles into space. Clustered boosters have already been dismissed by Professor Itokawa's rocket team in favor of the new booster design. ■



KAPPA 8 PAYLOAD is designed to take data in deep space.



POWER *(left) from a thermo-electric generator under R&D for space work.*

TUBE *(right) provides thermionic generation of power at Westinghouse Research Laboratories.*

SOLDERING *(below) of ferro-electric wafer on hydravoid production line at Baltimore for Missile System.*

Defense programs draw upon variety of facilities . . .

(Continued from page 13)

Westinghouse's large part of the ship-to-air *Typhon* missile system.

• **Reasons why**—Cresap said he based his forecast of the growth of company sales on the expected near-exhaustion of utility company stockpiles and the acquiring of new contracts on "important defense systems."

Westinghouse's net sales in calendar 1959 totaled $1,911,000,000. Of this about $344 million—18%—came from prime contracts and subcontracts for atomic and other defense space products. Net sales in calendar 1960 totaled $1,956,000,000. Of this, atomic and defense products accounted for about $391 million—20%.

The corporation's recently issued third-quarter report spoke of still further increases in defense orders despite declines in sales and low prices that affected net sales of other company products. Westinghouse's total net sales for the first nine months of the year totaled $1,388,000,000—$65 million under the three-quarter total for last year.

Cresap described the increase in defense orders as "sharp." And he estimated that the expected continuation of the increases will mean a sizeable boost in the Defense Product Group's percentage of net sales within the next few years.

• **Needs find capabilities** — The basis for his estimates is twofold: Changing requirements and expanding company capabilities in selected areas.

"More and more the role of electronics is accelerating in missile and space and other military systems," he said. "I think it will continue to accelerate.

"In the atomic area, the potentialities are just being scratched. Materials are becoming increasingly important. And the demand for new power sources is insistent."

The square-set executive paused and lit a cigarette.

"In all of these areas, we have large capabilities," he said. "For example, our work in power conversion has an affinity in this whole defense-space field. In the nuclear field, we started some time ago to meet a requirement that we saw coming for nuclear-powered rockets. And because of our commercial and industrial electronics business, we always have had to stay abreast of the whole materials technology."

Moreover, Cresap said, all of these capabilities are being expanded with an eye pointedly fixed on new NASA and Pentagon space programs.

"We keep changing the Westinghouse organization to design our capabilities to the situation," he said. "Only within the last few weeks, we established our new Space Materials Department near Pittsburgh. Within the last six months, we established our Astroelectronics Laboratory in California. And our Astronuclear Laboratory at Pittsburgh is already at work on the *Nerva* nuclear-powered rocket engine."

• **Coordination**—These three laboratories are only part of the facilities within the corporation that are being called on by the Defense Products Group to handle various defense contracts. In fact, all of the corporation comes under the Group's purview for possible contributions.

"The job of the Defense Group," Huggins said, "is to bring together, to marshal the capabilities of the entire corporation to perform complete weapon system assignments. *Typhon* is a good example. At least three divisions are participating and before we are through probably a half-dozen will be in the program."

To ensure that no capabilities are missed, Cresap has established within the Defense Group a Defense Advisory

POLARIS *(above) launching tube at Sunnyvale, Calif., plant.*

ASTOR *(right), at nuclear-tipped torpedo, undergoes final adjustment.*

HOT GAS *(far right top) blasts through magnetic field in first sizeable MHD unit to burn natural fuels.*

FUEL CELL *(far right bottom) in furnace produces electrical energy.*

Committee to survey the potential defense contributions of all of Westing- Committee to survey the potential dehouse's more than 100 plants and laboratories. General Boyd is committee chairman. Cresap attends all meetings.

However, although the Defense Group has the entire corporation at its call, it has directly under it only the Baltimore Divisions, the Astroelectronics Laboratory and the Space Materials Department. Rather than creating one special defense division as have a number of companies, Westinghouse chose to create an overall staff group with headquarters in Washington.

"We feel that this type of organization can better bring into play all of our capabilities," Huggins explained. "These have put us into a good position to take on system primes. We see no need to develop the capability to handle the air frames, which are of relatively declining importance in most cases and can be subcontracted out."

• **Two keys**—Two important factors underpinning Westinghouse's improving position in the missile/space market are continuing emphasis on cost reduction and research.

"Anybody who has a good cost reduction idea that he can prove out will get a go-ahead in this company," Cresap said. "We will find the money for it. This area is essential."

Earlier this year in an address to the Machine Tool Forum in Pittsburgh Cresap put his idea of cost reduction even more bluntly:

"We are determined to replace any piece of equipment, even if it is only one or two years old, if the new machine will give us the required return on the added investment. On the other hand, American industry wants to take the giant step forward. . . . The moderate increase in cutting speed, the 25% improvement in efficiency, just aren't good enough today."

In the field of research, Westinghouse is currently spending about $200 million a year on in-house and customer-ordered programs. The center of this research is at the sprawling Westinghouse Laboratories in Churchill Borough, about 10 miles from downtown Pittsburgh.

At Churchill Borough, some 1700 scientists, engineers and supporting personnel work in 450 scientific laboratories. Throughout the country, Westinghouse employs some 8000 scientists and engineers on R&E programs.

Great amounts of this research have been concentrated in the fields of nuclear power, materials and the generation of power by direct conversion.

• **Experience in depth**—The leaders of Westinghouse's expanding missile/space role—Cresap, Huggins and Boyd—are respectively a mangement expert, a lawyer and a crack test pilot.

Huggins joined Westinghouse in 1943 in the company's Baltimore law department. He served as Assistant Air Force Secretary in the Truman Administration. He is president of NSIA.

Boyd was deputy commander for weapons systems of the old Air Research and Development Command when he retired from the Air Force in 1957 and joined Westinghouse. At the time of his retirement, he had flown more than 300 types of aircraft for a total of some 13,000 hours.

Cresap joined Westinghouse in 1951 as vice president and assistant to the president after his management consulting firm had been employed by the corporation for more than a year. He became the chief executive of Westinghouse in 1959.

Among other things, he brought to the job a sharp insight into management problems, an incisive mind and a broad knowledge of history.

The same year he was named chief corporation executive, he probably summed up best in an address to the NSIA his approach to many of the problems of the defense industry and the world:

"Military technology today," he said, "is a race of science rather than of heavy volume production. The key problem is not how to get more but how to get better." ⌗

Martin-Orlando Reports Savings on Value Analysis

THE MARTIN CO.-Orlando says it has saved $18 million so far this year on value analysis.

Company spokesmen told a Pentagon Army value analysis seminar that the division had, since its inception five years ago, managed and delivered $770 million in defense contracts with less than one percent variance from contract price.

The seminar was told that "in the past two and one-half years, we have cut this variance to approximately one-third of one percent while maintaining production schedules."

A five-day value analysis symposium conducted in Orlando produced recommendations by representatives of the military and 14 manufacturing firms involved in the *Pershing* and *Bullpup* programs for potential savings of over $6 million.

In another development, Martin-Baltimore reported that in the six months ending Sept. 30, 84% of its procurement dollars were spent in labor surplus areas. ⌗

Financial Reports

COMPANY	PERIOD	INCOME		EARNINGS	
		1961	1960	1961	1960
Air Products & Chemicals, Inc.	Year, Sept. 30	$ 70,427,000	$ 61,195,000	$ 3,895,000	$ 2,495,000
American Bosch Arma Corp.	9 Mo. Sept. 30	99,560,909	93,289,510	1,477,763	981,976
American Electronics Inc.	9 Mo. Sept. 30	13,768,002	18,947,280	209,199	381,688
Boeing Co.	9 Mo. Sept. 30	1,309,259,940	1,202,225,628	26,072,956	16,167,061
Corning Glass Works	9 Mo. Sept. 30	170,115,129	165,481,036	18,481,194	17,580,333
Hoffman Electronics Corp.	9 Mo. Sept. 30	44,462,097	38,659,460	358,623	252,431
Lear, Inc.	9 Mo. Sept. 30	70,618,132	68,207,920	2,169,266	1,919,855
North American Aviation, Inc.	Year, Sept. 30	1,265,445,267	965,920,852	27,750,137	23,394,548
Specialty Electronics Dev. Corp.	Year, July 31	2,161,838	3,908,177	65,153	174,944
Systron-Donner Corp.	Year, July 31	6,688,000	5,396,000	600,000	477,000
Texas Instruments, Inc.	9 Mo. Sept. 30	171,937,000	170,147,000	7,065,000	11,517,000
U.S. Industries, Inc.	9 Mo. Sept. 30	69,093,000	68,720,000	2,207,000	−848,000

Orbital Rendezvous

(Continued from page 18)

• **Guidance** — Inertial guidance would probably be used to put the seeking vehicle into the neighborhood of its target. For the seeker to try to dock on its first orbit is said to be inadvisable because of the strain this maneuver would put on the ground support and guidance systems.

A conservative rendezvous operation would be: (1) after the target is in orbit, launch the seeker; (2) make midcourse corrections so that on its second orbit the seeker will be close to its target; (3) guide and control the seeker so that it will have the same velocity and attitude as the target; and (4) dock and begin coupling maneuvers.

Since early rendezvous will be between unmanned vehicles, thereby accenting the already difficult "docking" problem, reliance will have to be placed either on ground monitors to bring the vehicles together or on self-contained homing devices. It will be the last 1000 to 2000 feet between the vehicles that will be the most difficult to close.

The last few feet of closure may be handled automatically, perhaps by magnetic means. However, there is always danger of a "bump," which might seriously injure the vehicles or disturb their obits. A less sophisticated but perhaps more effective approach might be to use a television circuit, through which ground observers would issue the commands needed to bring the vehicles together.

• **Coupling**—Once they are near, the vehicles must be coupled. Intelligence and perhaps power will have to be transferred between the two vehicles. This calls for an umbilical, either mechanical or electrical.

For manned rendezvous, refueling might be the mission. The propellants would have to be transferred under pressure—assuming they are liquid—because the absence of gravity effects would eliminate the head. Thus, special pumps would have to be designed.

Kurt Stehling of NASA wrote recently that for the refueling operation in space "the slightest leak (in the pipe transferring) cryogenic propellants, if they were used, and at the high pressure ratios existing, would produce a giant cosmic steam-kettle effect."

Moreover, for the manned rendezvous, crew transfers from one vehicle to the other would require either "air-locking" together the doors of each vehicle, or permitting passengers to transfer by means of space suits—which have yet to be designed. ⌗

NASA-contracted orbital operation studies (FY61)

Subject	Months	Scheduled Completion	Contractor	Cost
Flight Performance Manual	6	May 1961	Martin	0
			Northrop	$ 57,380
			Space Tech. Lab.	92,620
Orbital Launch Operations	6	June 1961	Vought	112,156
			Douglas	92,165
Orbit Launched Vehicles	6	Sept. 1961	GD/Astronautics	58,000
Orbital Docking Demonstration	6	July 1961	Lockheed (STL)	100,000
Orbital Operations Based on Saturn System Capabilities	6	Dec. 1961	— — —	100,000
Analytical Study of a Satellite Rendezvous	12	Jan. 1962	North American	60,000
Orbital Transfer & Guidance Studies	12	Jan. 1962	Grumman	54,601
			Chrysler	30,000
			Univ. of Alabama	26,000
			Auburn Univ.	24,000
			Univ. of Kentucky	32,500
			Univ. of North Carolina	32,500
TOTAL				$871,922

names in the news

EVANS

UMSTATTD

HANS

MOYER

LEE

Herbert B. Evans: Named as vice president in charge of manufacturing and engineering of Harvick Manufacturing Corp., subsidiary of Tenney Engineering, Inc., Evans was formerly with Associated Piping and Engineering Company and with Bethlehem Shipyards Corp.

Dr. Wilbur A. Hane: Appointed chief scientist, The Boeing Co.'s AeroSpace Div., Seattle. Replacing him as chief of physics technology is **E. N. Sidor. R. L. Shahan** named chief of orbital and space systems support section, Physics Technology Dept. Shahan replaces **Robert Illman,** who joins Boeing's new Military Aircraft Systems Div. **M. L. Reeves** replaces Shahan as *Dyna-Soar* contract support chief in orbital and space systems support section.

Frank M. Sylvester: Appointed assistant to the president, Hagan Industries, Inc., Corona N.Y., where he will be in charge of ground support equipment programs. Prior to joining Hagan, Sylvester was with Lockheed Aircraft Service, Inc., and Pan American World Airways.

Walter D. Pitts: Joins Microwave Development Laboratories, Inc., Natick, Mass., as director of materiel.

Leo A. Weiss: Elected to board of directors, Nucleonics, Chemistry & Electronics Shares, Inc. He also is president and chairman of the board of Avien, Inc., which he founded.

William E. Umstattd, Chairman of the Executive Committee of the Timken Roller Bearing Company was appointed a Chevalier of the Legion of Honor by a decree signed by the President of the French Republic, Charles de Gaulle. Umstattd has been with Timken Roller Bearing Company since 1919, starting as an inspector, and being named president in 1934. Under his leadership the company tripled in size with new plants established in the United States, Canada, Great Britain, South Africa, Australia, Brazil and France.

Stanley Goldstein named project manager, and **Maurice Seisler,** section head, Ground Support Equipment, both in Systems Div., Avien, Inc.

James M. Blakely: Elected vice president of engineering and operations, Sonic Development Corporation of America, New York City. Blakely was assistant to the president, Dayco Corp., until last year when he entered the management consulting business.

Howard F. Marx: Formerly director of development planning, Temco Electronics and Missiles Co., appointed director of corporate planning, Ling-Temco-Vought, Inc.

Edmund Hans: Western Transistor Corporation of Gardena, Calif., has appointed Hans to the position of Director of Marketing. He was formerly associated with Thompson Ramo Wooldridge Components Co.

Dr. Guy Suits: General Electric vice president and director of research, has been chosen to receive the 1962 Industrial Research Institute Medal. Representing 175 U.S. companies, the Institute cites Dr. Suits' "skill and leadership in promoting the growth of an industrial research laboratory enjoying worldwide recognition . . . for successfully interpreting research results to company management and the general public and for varied technological advisory services to the government of his country."

Robert Peth: Promoted to manager, Engineering, Mobile and Portable Communications Products, Motorola's Communications Div. **John F. Mitchell** replaces him as chief engineer. **C. Harry Knowles** named assistant general manager, Research and Advanced Development, for Motorola's Semiconductor Products Div. in Phoenix, Ariz.

Dr. James W. Moyer: Has joined Servomechanisms/Inc. as director of research, Research and Development Center, Santa Barbara. Dr. Moyer previously served is director of research at the Sperry Rand Research Center, Sudbury, Mass. Prior to that, he was associated with the General Electric Company, with the Rochester Ordnance District and worked on the Manhattan Project at Berkeley and Oak Ridge.

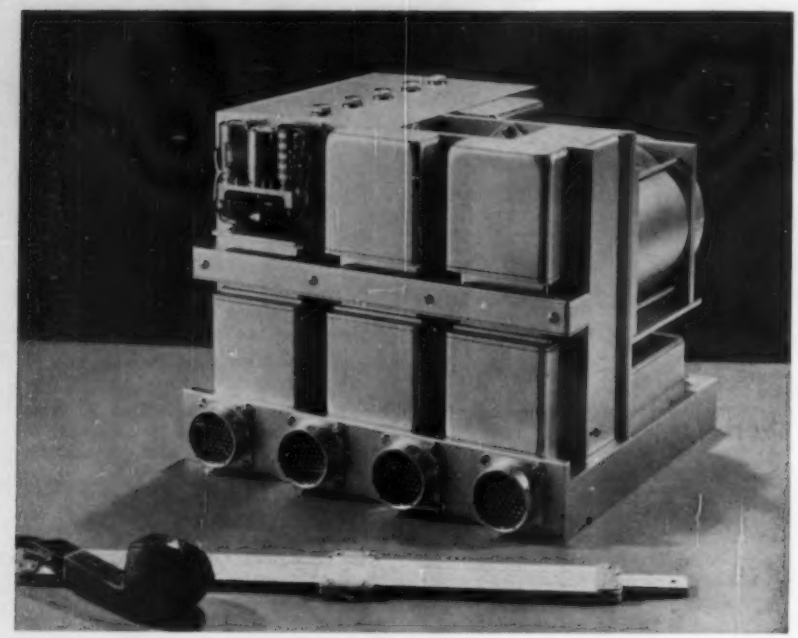
Robert B. Swope and **Robert P. McMillan:** Chairman and president, respectively, Southern Oxygen Co., elected to board of directors, Air Products & Chemicals, Inc., Allentown, Pa. Southern Oxygen was recently acquired by Air Products through an exchange of stock.

A. M. Andrews, Jr.: Appointed president of Airco Company International, a division of Air Reduction Company, Inc. Andrews has been with the company since 1944.

Gerhard Neumann: Appointed general manager, General Electric's Flight Propulsion Div., succeeding **Neil E. Firestone,** who is on special assignment with the company's Project *Apollo* team. **David F. Shaw** becomes general manager, Large Jet Engine Dept., Evendale, Ohio; **Edward Woll,** general manager, Small Aircraft Engine Dept., West Lynn, Mass., succeeding Neumann.

Robert H. Lee: Appointed to the new position of director of engineering for Kurz and Root Company, Appleton, Wis., and its subsidiaries. He will have direct supervision of engineering at all four division and subsidiary locations. Prior to his present position, Lee was director of engineering for Basler Electric Company and its affiliate, Power Supplies, Inc., of Illinois, and held the post of chief engineer of Rectifier Division, P. F. Mallory Company, Indianapolis, Ind.

Dr. Leo L. Beranek: Received the Wallace Clement Sabine Award of the Acoustical Society of America for his internationally recognized achievements in all phases of architectural acoustics. He is the president of Bolt Beranek and Newman, Inc of Cambridge, Mass. Also, **Dr. Albert B. Wood** of the Admiralty Research Laboratory in Teddington, Middlesex, England, received the Pioneers of Underwater Sound Award. Both recipients received the awards at the 62nd Meeting of Acoustical Society of America.



New Product of the Week: Miniature Digital Computer

The L-70, one of the world's smallest digital computers, is available from General Precision's Librascope Division.

The computer weighs only 19 lb. and employs a new design approach to the memory-drum concept. The L-70's memory drum, utilizes a thin film of helium as a bearing for the rotating drum. The entire memory system weighs slightly over 5 lb.

The drum spins on a thin film of gas instead of a metal bearing as in earlier systems. The design approach eliminates the mechanical wear of a metal suspension system and allows closer tolerances between the drum and the magnetic devices that record and withdraw data. This latter feature allows for greater memory capacity. The gas-bearing drum has been successfully tested at vibration and shock levels greater than current space-vehicle requirements.

Circle No. 225 on Subscriber Service Card

Electronic Chassis

Vent-Rak, Inc. is marketing an electronic chassis developed to permit high flexibility in electronic mounting. Eliminating the old "bread-board" concept of assembly, Vent-Rak offers boards in 4¼-in. increments that permit a wide variety of arrangements to suit individual requirements. The sub plates, which make up into a standard chassis 17 in. wide and up to 21¼ in. deep or larger, permit several engineers to work on the same project simultaneously, and allow each plate to be detached and replaced without modification.

Circle No. 226 on Subscriber Service Card

High-mu Triode

United Electronics Co., subsidiary of Ling-Temco-Vought, Inc., is marketing Tube No. 581, a miniature high vacuum high-mu triode designed for pulse modulator service. In this service it can deliver 13 kilowatts pulse power output. Maximum anode voltage is 20 kilovolts, peak plate current is 1.2 amperes, and grid bias is 300 volts.

Circle No. 227 on Subscriber Service Card

Servo-Motor Package

A compact servo-motor package featuring a highly integrated design is available from the Aero Hydraulics Division of Vickers Inc. Developed for missile and aircraft control systems, the package incorporates the hydraulic motor, servo valve and internal relief valves in one housing. Advantages include approximately 20% reduction weight, 30% reduction in size, a minimum volume of oil under compression, and an internal case drain. Use of a high-case-pressure motor reduces breakaway torque to only ⅛ that of a comparable manifolded standard motor and servo valve.

Circle No. 228 on Subscriber Service Card

Ag/Cd Button Cells

Pilot production of the first hermetically-sealed, rechargeable silver-cadmium "button cells" has been started by Yardney Electric Corp. Because each cell is only a little larger in diameter than a half-dollar, batteries of miniature size can be assembled that offer unlimited possibilities in electronic and electrical applications. This type of maintenance-free button cell will have up to 75% more capacity than ordinary rechargeable button cells of the same size, and a cycle life almost 60% greater. The company plans to make modules available of 0.25-, 0.50-, 1-, 2-, 4-, and 6 ampere-hour (D-size) capacity.

Circle No. 229 on Subscriber Service Card

Soldering Panel

A panel designed to consolidate several operations into one simple, fast and positive method of location in assembling or soldering groups of wires into various types of plugs, is available from Winslow Product Engineering Corp. Operation of panel is extremely simple; no operator training is necessary. To wire a given plug, the operator selects a plug adaptor and chart which matches the plug. Charts can be furnished to correspond with plug in either letter or number configuration. Adaptor and chart are inserted into

position on the panel. The operator then connects the plug to be wired to the plug adaptor and begins to wire. When the soldering iron or probe touches a plug pin the corresponding number, or letter, lights up on the chart. This indicates that the proper pin is being wired.

Circle No. 230 on Subscriber Service Card

Commutator

Datametrics Incorporated has a telemetry commutator featuring low contact noise and long life. Sampling rates as high as 1350 per second are offered with a standard 90-channel unit. Life is 1000 hours minimum at the highest sampling rate and increases as the sampling rate is reduced. Standard channel capacities are 30, 60, and 90, and up to 10 poles can be accommodated. Standard sampling speeds are 1, 2, 5, 10 and 15 revolutions per second. Contact noise is less than 5 volts, which permits strain gauge or thermocouple outputs to be fed directly into the Datacel wtihout preamplification.

Circle No. 231 on Subscriber Service Card

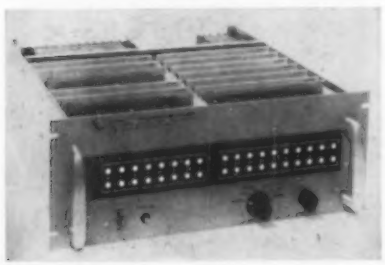
Epitaxial Transistors

General Electric Co. is marketing a new series of planar, epitaxial, passivated silicon transistors designed for use in industrial and military high-speed switching and high-frequency amplifier circuits. The transistors operate at frequencies from 50 megacycles to above 120 megacycles. The six transistors which comprise the P.E.P. series have been designated types 2N2193 through 2N2195 and 2N2193A through 2N2195A. In addition, the firm has available seven silicon planar transistors. These components are types 2N696 through 2N699, 2N1613, 2N1711 and 2N1893.

Circle No. 232 on Subscriber Service Card

Magnetic Core Memories

A series of magnetic core memories for use in the design of data conversion and data processing systems is available from the Electronic Engineering Co. The EECO 8-level series has a capacity of 128 to 2048 characters and is available in three different models; random access, sequential access, and sequential interlace. Because of the variation of character capacity and the access, a total of 15 models of the new 8-level series are available. Speed of the new series is 200 kc or 5 microseconds between load and unload commands. Readout is non-destructive and data remains in the memory until new data is loaded or the ERASE signal is received. An ERASE signal will clear the entire memory. Separate front panel indicators display each bit in input register, output register, load address, and unload address.



Circle No. 233 on Subscriber Service Card

Silicon Power Supplies

S-series 24-volt and 50-volt power equipment developed by Raytheon Co. features non-aging silicon power rectifiers to help reduce cabinet size by as much as 50%. Designed for wide communications applications, the power supplies include battery chargers, battery eliminators, and end-cell chargers. Simplified and standardized ferro-resonant design is employed to eliminate extraneous semiconductor control circuitry and increase unit reliability and operational life. All S-Series power supplies provide stable and filtered d-c regulated to within ±1 percent of the

Test facilities • Laboratories • Production plants
a turnkey service by Stearns-Roger

For years Stearns-Roger has been a pioneer in the designing and building of high pressure – low temperature facilities for gas processing and handling. Complete LH_2 plants are the products of Stearns-Roger engineering and construction services. Investigate our qualifications in Cryogenics, Nuclear Facilities, as well as Missile and other defense-related installations. Write for details of our SINGLE RESPONSIBILITY SERVICE.

Stearns-Roger
THE STEARNS-ROGER MFG. CO. • DENVER, COLORADO

P.O. BOX 5888 • DENVER 17, COLORADO

DESIGNERS • ENGINEERS • CONSTRUCTORS • MANUFACTURERS

Circle No. 6 on Subscriber Service Card

rated value with loads from 0-100% and AC line variations from 95-130. Complete overload and short circuit protection is built into the design.

Circle No. 234 on Subscriber Service Card

Slotted Lines

Antenna Systems, Inc., is marketing a complete line of slotted lines in all waveguide sizes from WR-430 through WR-2300. The residual VSWR is 1 less than 1.02 and the slope is less than 0.1 db. The standard units are supplied with a broad bank probe, but tunable or RF probes are available on request. The line can be calibrated in either inches or centimeters.

Circle No. 235 on Subscriber Service Card

Voltage Reference

Isolation from line voltage changes in the order of 100 db is one of the primary features of a voltage reference supply available from CircuitDyne Corp. A solid-tate device, designated Type PR1, the VR source is available in models to accept both 115 volt and 6.3 volt inputs, from 50 to 400 cps. Outputs may be specified at 5.9, 8.6, 11.0, 14.5, 17.2 and 22.0 volts, nominally. Actual

output voltages are calibrated for each individual unit and stamped on the case.

Circle No. 236 on Subscriber Service Card

Multiplier Phototube

A 2 in.-diameter head-on type of multiplier phototube is available from the RCA Electron Tube Division. The RCA-8053 is the third of a trio of recently developed RCA phototubes utilizing a venetian-blind dynode structure and having S-11 response.

Design features of the tube include a semi-transparent photocathode having a minimum useful diameter of 1.68 in.; a first dynode having large area; a flat window to facilitate the mounting of flat phosphor crystals; and 10 dynode (secondary emitter) stages. The RCA-8053 has a median radiant sensitivity of 1.5 x 10^4 amperes per watt at 4400 angstroms (approximately 20 amperes per lumen) when operated at a supply voltage of 1500 volts.

Circle No. 237 on Subscriber Service Card

Thermoelectric Coolers

A line of 2- and 3-stage cascade thermoelectric coolers that will reach −95°C from a sink temperature of +20°C with an input of only 3.0 amps max. is available from Jepson Thermoelectrics. Varying the current varies temperature. These 2- and 3-stage cascade coolers eliminate the comparatively immense weight and bulk of CO_2 cooling systems and storage tanks usually required to cool infrared and photoelectric cells and parametric amplifiers in missile and commercial applications.

Circle No. 238 on Subscriber Service Card

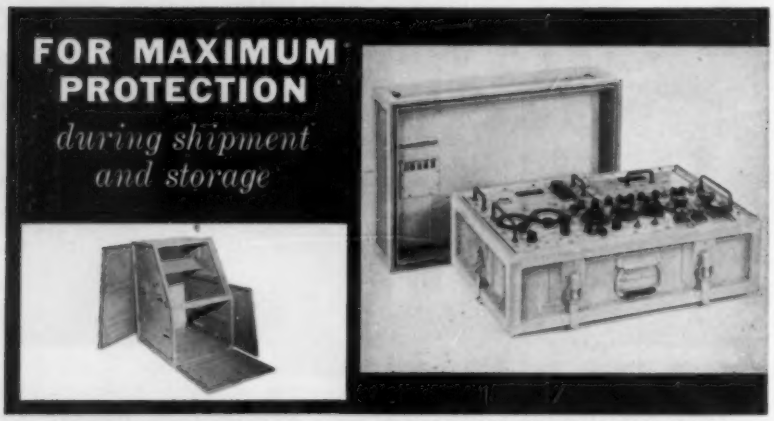
Digital Recorder

A new digital recorder featuring high-speed, flexible data input with information storage is now available from Hewlett-Packard Company. The transistorized, electro-mechanical recorder can print up to five 11 digit lines per second. A storage feature allows data transfer in 2 milliseconds, after which the driving source is released to gather more information. Internal connectors route paralled-entry data to any described digit, and different input codes may be used for each digit.

Circle No. 239 on Subscriber Service Card

Sampling Oscilloscope

A sampling oscilloscope which gives calibrated, high-resolution measurement of nanosecond pulse phenomena is available from Hewlett-Packard Company. Model 185B features conventional controls, direct reading and bright-trace observation, and a standard 5-in. mono-accelerator CRT. When



Complies with MIL-C-22443 (WEPS)

THE NEW ZERO MODULAR PACKAGING SYSTEM

The new Zero Modular Shipping/Storage Container System combines the advantages of light weight and great structural strength with versatile dimensioning to provide trim and good appearing aluminum shipping and storage containers with minimum weight and cube. Sensitive electronic and mechanical gear, missile components... even complete missiles receive requisite shock and environmental protection through the use of this versatile system.

Write for Modular Catalog E59

Zero **ZERO MANUFACTURING CO.**
1121 Chestnut Street, Burbank, California
Factories in Burbank, Calif. and Palmer, Mass.
Telephone VIctoria 9-5521 • TWX BRB-9862

representatives in key cities covering the U.S.

Circle No. 7 on Subscriber Service Card

equipped with a Model 187B Plug-In Dual Trace Amplifier, the Model 185B to 1000 mc, can be synchronized up to to 1000 mc, acn be synchronized up to 1000 mc, and permits full-screen presentation of signals from 0.3 nanosecond to 100 microseconds.

Circle No. 240 on Subscriber Service Card

Push-Pull Switch

A push-pull switch design resulting in savings up to 60% assembly time costs of wiring operations is available from Clarostat Mfg. Col, Inc. The Series AG Push-Pull Switch for control/switch combinatoins completely eliminates the need for solder shields and

results in greater dependability through better access to terminals during soldering operations. The Series AG employs a design technique whereby the usual rim holding the terminal board is eliminated.

Circle No. 241 on Subscriber Service Card

Wave Tube

A miniature traveling wave tube that will provide high power and broad bandwidth for space communication systems is in production at the Sperry Electronic Tube Division. Called the STX-186, the amplifier produces more than 10 watts over frequency ranges from 5000 to 11,000 mc. The 9-in. long, 1-lb. traveling wave tube is capable of realizing a 40-db gain. Beam voltage is held to 2200 volts.

Circle No. 242 on Subscriber Service Card

Carbon Film Resistors

A line of precision carbon film resistors is available from Pyrofilm Resistor Co. The PT-D Series incorporates gold flash protected Dumet leads making them ideal for welded packaging techniques. These weldable leads provide exceptional strength and resistance to twisting, at least 25 lbs. and 10°-360° twists.

Circle No. 243 on Subscriber Service Card

new literature

MICROWAVE—A catalog listing over 200 standard microwave components and solid-state devices is available at E & M Laboratories. Included in the catalog are the several hundred new items developed during the past year as well as an updating of the specifications which appeared is last year's catalog. Described are waveguide isolators, coaxial isolators, duplexers, switches, electronic attenuators, modulators, phase shifter, and circulators, as well as the pertinent electrical and physical characteristics of each unit.

Circle No. 200 on Subscriber Service Card

GEARS/CLUTCHES—SIAMCO, Division of Tech-Ohm Electronics, has available its new 140-page catalog #100. This catalog features such items as precision gears, magnetic clutches and brakes, differentials, couplings, gear heads, limit stops, bearings, electronic hardware and other items which have application in the electro-mechanical field.

Circle No. 201 on Subscriber Service Card

SIGNAL CONDITIONER—Astra Tech's Bulletin 201 dscribes the first model (TSC-1) of the company's thermocouple signal-conditioning line. The TSC-1, depicted brochure, is available as a single-channel system and expandable to eight channels through plug-in cards. Design is compact, smaller than other commercially available thermocouple signal conditioners. The unit has five front-panel operating controls. Complete physical and electrical specifications are provided, as well as a photograph of the TSC-1. Available accessories are listed and described.

Circle No. 202 on Subscriber Service Card

RECORDERS—Null Balance Recorders and Recording Controllers—(GEA-6887A.) 12 pages, describes General Electric's complete line of single and multi-pen null balance recorders and recorder-controllers. Also discussed are multi-point recorders and multi-purpose indicators. Descriptions of typical measurements performed by the recorders and controllers are outlined in a special section. The illustrated bulletin contains information on features, dimensions, specifications, optional accessories and applications.

Circle No. 203 on Subscriber Service Card

NJC

MICRO
PRECISION
HOLES

FROM .0001" DIA.

DRILLS
DRILLING MACHINES
EXPENDABLE TOOLING
DRILLING SERVICE
MICRO-MACHINING
CONSULTANTS

NATIONAL JET CO.
10 CUPLER DR.—LaVALE
CUMBERLAND, MARYLAND
CABLE ADDRESS: NAJET

Circle No. 8 on Subscriber Service Card

You Get Things Done With Boardmaster Visual Control

☆ Gives Graphic Picture of Your Operations—Spotlighted by Color
☆ Facts at a glance — Saves Time, Saves Money, Prevents Errors
☆ Simple to operate — Type or Write on Cards, Snap in Grooves
☆ Ideal for Production, Traffic, Inventory, Scheduling, Sales, Etc.
☆ Made of Metal, Compact and Attractive. Over 500,000 in Use

Full price $49.50 with cards

FREE 24-PAGE BOOKLET NO. L-50 Without Obligation

Write for Your Copy Today

GRAPHIC SYSTEMS
YANCEYVILLE, NORTH CAROLINA

Circle No. 9 on Subscriber Service Card

Employment

Gov't and Commercial contract management opportunities at Honeywell

ACCOUNT MANAGER

High level management position requiring ability to direct a complete account administration team and including responsibility for direction of all phases of business for major programs. Position involves continuous contact with all levels of management, both with customers and internally. Practical experience in decision making in all areas of business management, including: program planning and budgeting; program monitoring from initiation to completion; customer negotiation and liaison; proposal preparation; personnel management and supervision. A college degree and strong business management orientation preferred, including heavy experience in government contract management.

ACCOUNT ADMINISTRATORS

Program management positions including responsibility for direction of all phases of business for assigned accounts. Entails proposal preparation, contract negotiation, and post-award program administration. Position requires close liaison with all levels of management, both with customers and internally, to insure contract fulfillment. Practical experience in decision making in all areas of business management, including: program planning and budgeting; program monitoring from initiation to completion; customer negotiation and liaison and proposal preparation. A college degree and strong business management orientation preferred, including experience in administration of government contracts.

Send résumé to Mr. John Gibson, Employment Manager, Honeywell-Aero, 1437 Stinson Blvd., Minneapolis 13, Minnesota

Honeywell

To explore professional opportunities in other Honeywell locations, coast to coast, send your application in confidence to Mr. H. G. Eckstrom, Honeywell, Minneapolis 8, Minnesota.

An Equal Opportunity Employer

contracts

AIR FORCE

$17,040,000—**The Martin Co.**, Denver, for continued development and fabrication of *Titan* missiles.

$10,925,000—**The Martin Co.**, Denver for research, development and testing of *Titan II* missiles.

$8,736,500—**Hughes Aircraft Co.**, Culver City, Calif., for production of *Falcon* missiles and related items (2 contracts).

$4,320,000—**Hercules Powder Co.**, for production of third-stage engines for *Minuteman;* work to be done at Bacchus, Utah.

$1,328,978—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for work on classified project.

$1,120,000—**Boeing Co.**, Seattle, for support of *Minuteman* work at Whiteman AFB, Mo.

$636,150—**Farina Corp.**, Newton, Mass., for construction of a gaseous physics research building at Laurence G. Hanscom Field, Bedford, Mass., for operational use of the AF Cambridge Research Laboratories' Electronics Research Directorate.

$200,000—**Thiokol Chemical Corp.**, Wasatch Div., Brigham City, Utah, for solid-propellant grain core mandrels.

$95,400—**Goodyear Aircraft Corp.**, Akron, Ohio, for fabrication and testing of a five-foot-diameter model directional passive satellite.

ARMY

$20,430,915—**Western Electric Company** (work to be performed in Burlington and Greensboro, N.C.), for production of ground equipment for the improved *Nike-Hercules* air-defense guided missile system. Sharing in the contract funding will be **General Electric Co., Syracuse, N.Y.** and **Steel Products Company**, Springfield, Ohio.

$1,015,729—**Sperry Rand Corp., Sperry Utah Co.**, Salt Lake City, Utah, publications for the *Sergeant* guided missile system (2 contracts).

$396,693—**Stolte, Inc.**, Los Angeles, for technical facilities and missile-handling facilities at Vandenburg AFB, Calif.

$212,000—**The Martin Co.**, Orlando, Fla., for *Pershing* weapon system.

$79,090—**Sperry Rand Corp., Sperry Utah Co.**, Salt Lake City, for repair parts for *Sergeant* system.

$66,387—**Gilfillan Bros., Inc.**, Los Angeles, for spare parts for the *Corporal* missile system.

$42,180—**Douglas Aircraft Co., Inc.**, Santa Monica, Calif., for field change kits and repair parts for *Nike/Ajax, Hercules.*

$39,977—**Douglas Aircraft Co., Inc.**, Santa Monica, Calif., for repair parts for *Nike-Hercules* missile.

$38,735—**Douglas Aircraft Co., Inc.**, Santa Monica, for aeroballistic engineering services, improved *Honest-John* missile without warhead.

$35,188—**Douglas Aircraft Co., Inc.**, Santa Monica, for *Nike* replenishment repair parts, actuator.

$25,278—**Western Electric Co., Inc.**, New York City, for replenishment repair parts, *Nike* missile.

MISCELLANEOUS

$4,600,000—**Space Technology Laboratories, Inc.**, Los Angeles, from **Sanders Associates, Inc.**, Nashua, N.H., Subcontract for production of broadband power amplifier.

$800,000—**Thompson Ramo Wooldridge Inc., Dage Div.**, Michigan City, Ind., from **General Dynamics/Astronautics**, San Diego, Calif., for closed-circuit television equipment to be used in connection with the AF series *Atlas* ICBM program.

$765,600—**Collins Radio Co.**, Dallas, from **McDonnell Aircraft Corp.**, St. Louis, for horizontal situation indicator equipment.

$500,000—**Ampex Corp.**, Redwood City Calif., from **Bell Telephone Laboratories**, for advanced video magnetic tape recorders.

$372,000—**Sylvania Electric Products Inc.** from **General Electric Co., Ordnance Dept.**, Pittsfield, Mass., for production of electronic plug-in modules for the *Polaris* submarine Mark 84 fire control system.

$325,197—**Collins Radio Co.**, Cedar Rapids, Iowa, from DOD, for electronic equipment for the three services.

$130,000—**Systems Div., Electro-Mechanical Research, Inc.**, Sarasota, Fla., from **Ball Brothers Research Corp.**, for MICRO-POWER PCM telemetry systems for use in the NASA *S-17* orbiting solar observatory.

$110,000—**Geoscience Ltd.**, Solano Beach, Calif., basic research contract from the Atomic Energy Commission in connection with auxiliary nuclear power space systems.

NASA

$1,758,258—**Hughes Aircraft Co., Hughes Research Laboratories Division**, Malibu, Calif., for continued R&D of a cesium-powered ion rocket engine.

$1,400,000—**Republic Aviation Corporation**, Farmingdale, L.I., N.Y., for development and supplying of tooling and assembly fixtures for use in production of the *Saturn* vehicle, and also for production of a number of the structural components.

$95,000—**North American Aviation**, Los Angeles, for study of technical feasibility of a large erectible manned space station.

NAVY

$9,556,832—**Magnavox Co.**, Fort Wayne, Ind., for sonobuoys.

$2,901,672—**General Electric Co.**, Utica, N.Y., for guidance control equipment for *Sidewinder* missiles.

$2,404,795—**General Electric Co.**, Pittsfield, Mass., for engineering services in connection with the *Polaris* program.

$1,800,000—**Westinghouse Electric Corp.**, Baltimore, for production of underwater launch and sea energy recorder systems for use in connection with *Polaris* launching system.

$1,000,000—**Radio Corp. of America**, Camden, N.J., for electronics equipment.

$200,000—**Hamilton Watch Company, Military Products Division**, Lancaster, Pa., for manufacture of safety and arming programers to be used on the *Terrier* and *Tartar* missiles.

$49,520—**North American Aviation, Inc.**, Columbus, Ohio, for study to determine or establish the validity of using multiplying factors and/or applied ratios for the design and test of airframe structures subjected to elevated temperatures.

$47,820—**Rocket-Power Inc., Div. of Gabriel Co.**, Mesa, Ariz., for rockets, 6 ea.

$25,584—**Scientific Services Lab., Inc.**, Dallas, for sub-bottom reflection equipment.

when and where

NOVEMBER

Northeast Research and Engineering Meeting, IRE, Somerset Hotel and Commonwealth Armory, Boston, Nov. 14-16.

19th Annual Aerospace Electrical Society Display, Pan Pacific Auditorium, Los Angeles, Nov. 15-17.

First Conference on Medical and Biological Problems in Space Flight, Bahamas Conferences, Nassau, Nov. 19-24.

Electron Devices Meeting, IRE, Shoreham Hotel, Washington, D.C., Nov. 20-21.

11th Semi-annual Meeting and Midyear Conference of the Manufacturing Chemists' Association, Inc., New York City, Nov. 21.

ASME Winter Annual Meeting, Statler Hilton Hotel, New York City, Nov. 26-Dec. 1.

DECEMBER

Annual International Visual Communications Congress, co-sponsored by Society of Reproduction Engineers, American Institute for Design and Drafting and the American Records Management Association, Biltmore Hotel, Los Angeles, Dec. 2-5.

National Aerospace Support and Operations Meeting, sponsored by Institute of the Aerospace Sciences, San Juan Hotel, Orlando, Fla., Dec. 4-6.

19th Annual Electric Furnace Conference, the Metallurgical Society of AIME, Penn-Sheraton Hotel, Pittsburgh, Dec. 6-8.

Eastern Joint Computer Conference, sponsored by IRE-PGEC, AIEE and ACM, Sheraton Park Hotel, Washington, D.C. Dec. 12-14.

Annual Meeting, American Association for Advancement of Science, Denver, Dec. 26-31.

Annual Meeting, American Statistical Association, Roosevelt Hotel, New York, Dec. 27-30.

JANUARY

8th National Symposium on Reliability and Quality Control, Statler-Hilton Hotel, Washington, D.C., Jan. 9-11.

National Plant Engineering and Maintenance Show and Conference, Convention Hall, Philadelphia, Jan. 22-25.

Solid Propellant Rocket Conference, ARS, Baylor University, Waco, Tex., Jan. 24-25.

FEBRUARY

Western Electronic Week and Pacific Electronic Trade Show, Las Vegas and Los Angeles, Feb. 3-11.

Winter Convention on Military Electronics, IRE, Ambassador Hotel, Los Angeles, Feb. 7-9.

International Solid State Circuits Conference, Philadelphia, Feb. 14-16.

30th Annual Symposium on Nondestructive Testing of Aircraft and Missile Components (Southwest Research Institute), Gunter Hotel, San Antonio, Feb. 27-March 1.

MARCH

5th Annual Technical Conference, Society of Vacuum Coaters, Sheraton-Cleveland Hotel, Cleveland, March 6-7.

Armed Forces Communications and Electronics Association, Cape Canaveral Chapter, symposium to be held in Cocoa Beach, March 6-8.

1962 Symposium on Packaging of Chemical Products, sponsored by Manufacturing Chemists' Association, Inc., St. Louis, March 13-14.

Advertisers' Index

Aerojet-General Corp., Sub. General Tire & Rubber Co.... 51
Agency—D'Arcy Adv. Co.

AiResearch Mfg. Co., Div.-The Garrett Corp. 3
Agency—J. Walter Thompson Co.

General Electric Co., Light Military Electronics Dept. 52
Agency—George R. Nelson, Inc.

Graphic Systems 47
Agency—Caswell Adv. Agency

Instrument Development Labs..... 28
Agency—Horton, Church & Goff, Inc.

Minneapolis Honeywell Regulator Co., Aero Div..... 48
Agency—Batten, Barton, Durstine & Osborn, Inc.

Morehouse-Cowles, Inc. 2
Agency—Willard G. Gregory & Co.

National Jet Co. 47

Northrop Corp. 8
Agency—Doyle, Dane, Bernbach, Inc.

Poly-Scientific Corp. 7
Agency—Houck & Co., Inc.

Radio Corp. of America, Defense Electronics Products 26, 27
Agency—Al Paul Lefton Co., Inc.

Remington Rand UNIVAC Div., The Sperry Rand Corp..... 6
Agency—Mullen & Associates, Inc.

Stearns-Roger Mfg. Co..... 45
Agency—Mosher, Reimer, Williamson Adv. Agency, Inc.

United Technology Corp., Sub-United Aircraft Corp..... 4
Agency—Campbell-Ewald Co.

Wayne George Corp..... 11
Agency—Meissner & Co., Inc.

Zero Manufacturing Co., Inc..... 46
Agency—Guerin, Johnstone, Gage, Inc.

M/R BUSINESS OFFICES

Washington 5, D.C.—1001 Vermont Avenue, NW; STerling 3-5400
Edward D. Muhlfeld, Publisher

New York 17, N.Y.—20 East 46 Street; YUkon 6-3900
Paul B. Kinney, Eastern Advertising Manager
Paul N. Anderson

Beverly Hills, California—8929 Wilshire Blvd.; OLeander 5-9161
Ronald L. Rose
Edwin J. Denker, Jr.

San Francisco, California—859 The Dalles, Sunnyvale; RE 6-4017
James W. Clear

Detroit 2, Michigan—412 Fisher Building; TRinity 5-2555
Michael Rouff

Chicago 2, Illinois—139 N. Clark St.; Central 6-5804
R. Lenn Franke, Jr.

Dallas 24, Texas—222 Wynnewood Professional Building
John L. Hathaway

Miami, Florida—208 Almeria Ave., Coral Gables
Richard D. Hager

London, W.1., England—28 Bruton Street; Grosvenor 8356
Norall and Hart

Geneva, Switzerland—10 Rue Grenus; Geneva 321044

Paris, France—11 Rue Condorcet; TRU 15-39

Frankfurt/Main, West Germany—Friedrich-Ebert-Anlage 3

Employment

GUIDED MISSILE ENGINEERS FOR EUROPE

Leading missile company has openings for:

Servomechanism System Engineer (MS) with excellent theoretical background for research in airborne control and guidance systems.

Mechanical Engineer (MS) with several years experience in developing mechanical components for airborne guidance systems. **Aerodynamicist** (MS) as a group leader, with at least 5 years experience in guided missile aerodynamics.

Applicants should be willing to stay in Europe at least 2 years. Round-trip paid. New York interview.

Apply Box No. 71

MISSILES AND ROCKETS Magazine
1001 Vermont Ave., N.W.
Washington 5, D.C.

editorial . . .

Closing the Weather Gap

THIS WEEK, representatives from 28 nations, including the Soviet Union, are gathering in Washington for an international workshop on the U.S. weather satellite program.

The visitors will tour NASA's Wallops Island station. They will be shown the *Tiros* weather satellite. They will be instructed at laboratory sessions on interpretation of *Tiros* photographs.

They will be briefed on the infrared equipment carried aboard.

Data from all three *Tiros* satellites will be presented and future plans for U.S. meteorological systems will be explained in detail. These include four more *Tiros* launches and the inaugural 1962 launch of the more advanced *Nimbus* program.

Intent of the workshop is to demonstrate this nation's willingness to share the information from its weather satellites with all nations of the world, not excepting Russia.

The program will emphasize one of the most successful U.S. satellite programs, one which is an outstanding example of the peaceful uses of space. All three *Tiros* launches have been successful. Some 70,000 useful cloud photographs have been taken and transmitted to earth.

Practical value of the system was brought out in a recent speech by T. Keith Glennan, president of the Case Institute of Technology and former NASA administrator, before the International Air Transport Association's annual meeting in Australia. He told the airline delegates:

"It seems clear that meteorological satellite systems—which I expect will be operational within five years or less—will provide your operating people with weather forecasts of much greater accuracy and longer lead time than is the case at present . . . It will be an important step forward in the improvement of service and the comfort of your passengers."

As Dr. Glennan pointed out, *Tiros III* conclusively demonstrated its worth in the case of Hurricane Esther, which smashed into the U.S. Gulf Coast two months ago with extensive damage but low loss of life. This was the timetable on the Sept. 10 detection of Esther:

3:10 p.m. EDT. *Tiros III* recorded on command a series of photographs as it passed over the hurricane-spawning grounds in the South Atlantic.

4:34 p.m. Completing another orbit of the earth, *Tiros III* transmitted the pictures as it passed over the read-out station at Pt. Mugu, Calif.

6:00 p.m. Meteorologists of the U.S. Weather Bureau completed their preliminary analysis and telephoned a warning to the National Meteorological Station at Suitland, Md. The satellite had provided a good "fix" on a suspicious cloud formation at 11 degrees north latitude, 30 degrees west longitude. The Pt. Mugu weathermen then began translating the cloud photos into diagramatic charts.

7:00 p.m. The Hurricane Warning Center at Miami was alerted to the possibility of the formation of a hurricane.

7:55 p.m. Pt. Mugu completed its diagraming and transmitted the charts by direct facsimile to the National Meteorological Center.

11:00 p.m. Transmission of the diagrams to all principal weather bureaus over the National High Altitude Facsimile System was completed.

Thus, in less than eight hours from the time *Tiros III* took the photographs, they were translated into useful forecasts in the hands of U.S. weathermen.

Two days later, a hurricane-hunter plane entered the storm and verified winds of hurricane force. It was a dramatic demonstration of the value of a weather satellite system.

FIRMS SUCH AS Radio Corporation of America, prime and system contractor on the satellite and its instrumentation, Hoffman Electronics, system contractor of the power units, and Douglas Aircraft, prime contractor for the *Thor-Delta* booster, together with the many firms associated with them, can take pride in the fact that the early warning from *Tiros III* was instrumental in the saving of many lives.

Beyond *Tiros* lies *Nimbus*, the second-generation weather satellite on which General Electric is prime. And beyond *Nimbus* is *Aeros*, a system of 24-hour satellites which together with one or more satellites launched into polar orbit will provide continuous observation of the earth's cloud cover.

Data analysis techniques being developed in these programs are leading to a revolution in weather forecasting which will benefit all nations of the world. NASA and the Weather Bureau are to be complimented for the decision to make as much information as possible available at this early date.

We now would like to ask Mr. Khrushchev when he is planning to hold an international workshop on the Soviet Union's "peaceful" space program. When will international delegates be invited to study your satellites and view your launch sites, Mr. Prime Minister?

Your delegates are welcome in Washington and at Wallops Island. When may we expect a return invitation, Mr. Khrushchev?

William J. Coughlin

AVAILABLE
from Aerojet

for fast, sure inspection of
solid rocket propellant grains

GIGI

Gamma
Inspection of
Grain
Integrity

GIGI is a completely automatic nuclear-electronic detection system, replacing radiographic film for production inspection of the barrel sections of solid rocket motors. It is also a powerful research tool for flaw analysis, grain aging, and transportation damage studies.

FAST—Inspects Polaris-size motor in 6.3 hours. Film systems take 18.

ECONOMICAL—Requires one or two man crew. Film systems use four.

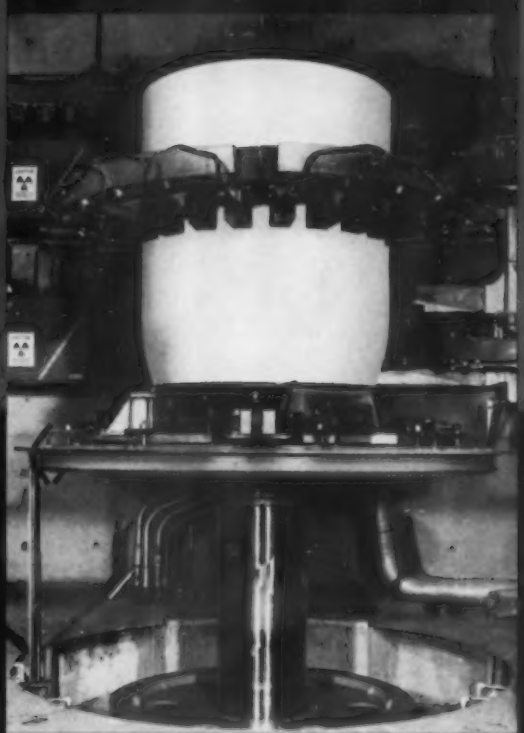
SENSITIVE—Spots flaws as small as 1/250 of a cubic inch at a 95% confidence level. Four times the sensitivity achieved with film.

RELIABLE—Requires no subjective interpretation. Results presented digitally or on analog strip charts.

FLEXIBLE—Sensitivity can be relaxed to increase speed as propellant integrity is proven.

A custom-engineered GIGI is now available in a range of speeds, sensitivities, and costs adaptable to rocket motor production and acceptance inspection.

AEROJET-GENERAL NUCLEONICS
San Ramon, California



GIGI was developed by Aerojet-General Nucleonics to speed Polaris inspection and increase reliability. It slashed in half the time required for solid grain inspection.

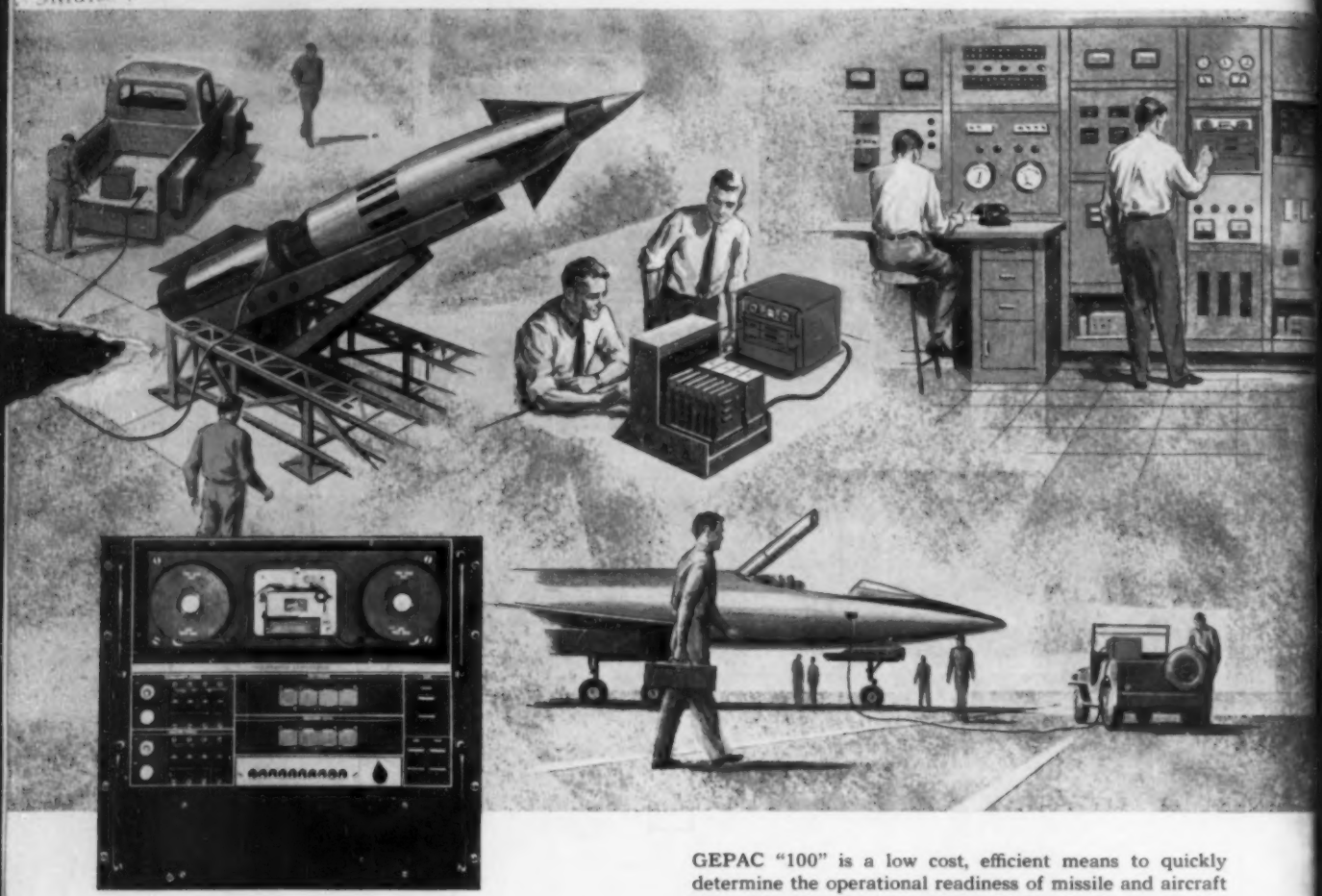
Aerojet-General
CORPORATION
A SUBSIDIARY OF THE GENERAL TIRE AND RUBBER COMPANY

Engineers, scientists—Investigate outstanding opportunities at Aerojet

GENERAL ELECTRIC

LMED

. . . LEADER IN AERO/SPACE ELECTRONICS



GEPAC "100"

Compact, portable programmable comparator for automatic checkout

GEPAC "100" is a low cost, efficient means to quickly determine the operational readiness of missile and aircraft electronic systems. This General Electric Programmable Automatic Comparator is portable—only 19½ x 20 x 17 inches in size.

Completely transistorized, GEPAC "100" uses punched-tape test programs and appropriate adapters to check automatically the following eight basic parameters:

• DC VOLTS • AC VOLTS • RESISTANCE • TIME
• IMPEDANCE • RATIO • PHASE • FREQUENCY

Measured values are compared with allowable high and low limits which have been programmed on the tape, and test results are visually displayed or can be printed out.

GEPAC "100" was developed by G.E.'s Light Military Electronics Department and is currently being supplied for two important Air Force programs. It is another example of LMED's leadership in aero/space electronics. Write for free brochure. 150-06

GENERAL ELECTRIC

Light Military Electronics Department
Armament & Control Section, Johnson City, New York

Circle No. 5 on Subscriber Service Card